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DECISION PROCESSES IN WATER QUALITY
MANAGEMENT

Richard M. Males, et al

Engineering Science, Incorporated
Oakland, California

April 1971

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Decision Processes in Water Quality Management



Engineering-Science, Inc.

DECISION PROCESSES IN WATER QUALITY MANAGEMENT

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April 1971

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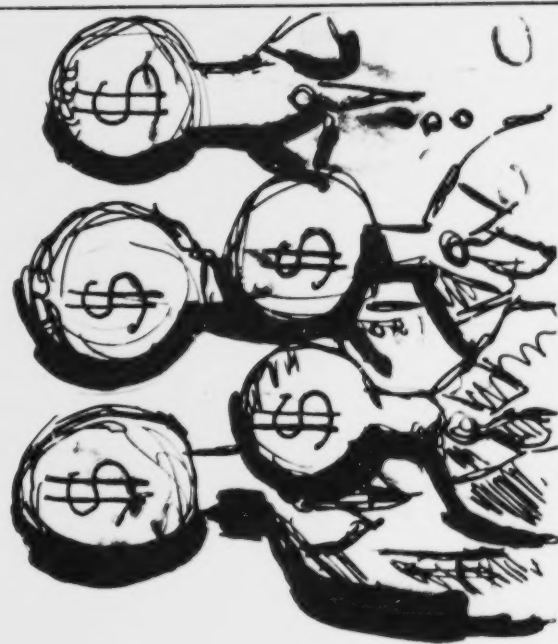
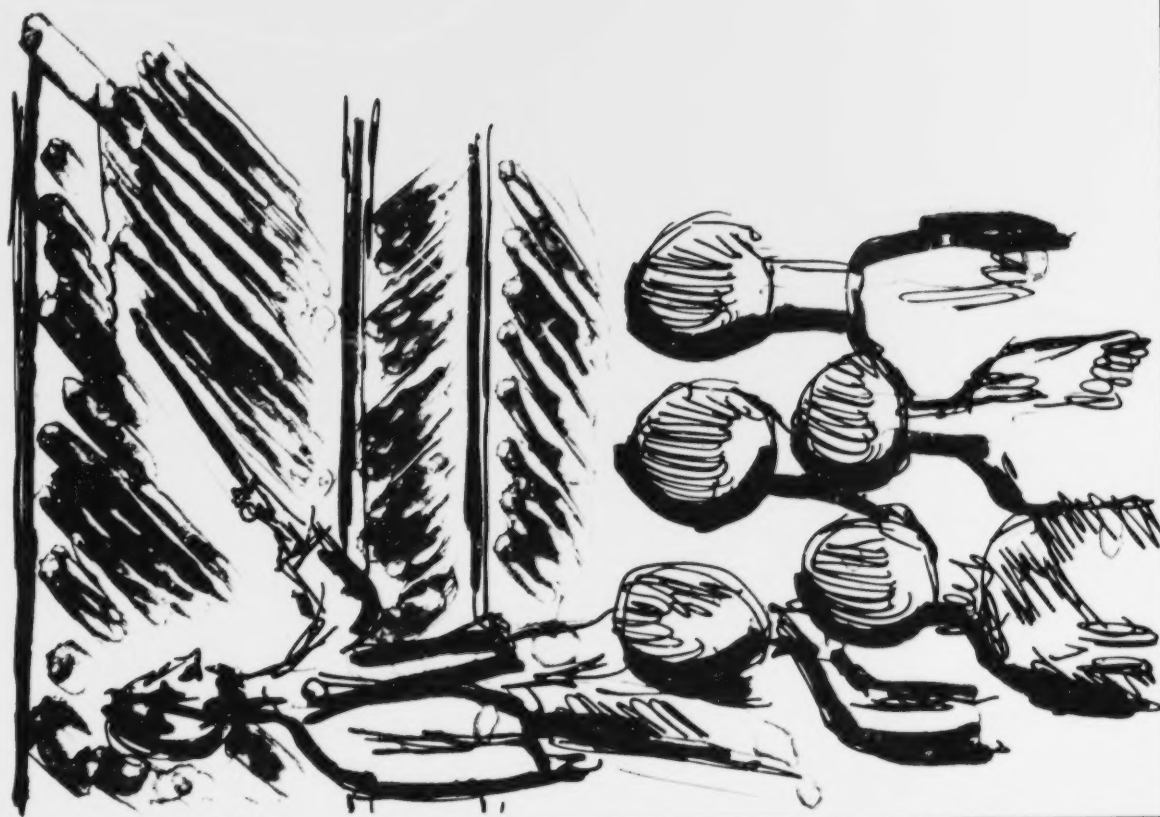
This report, entitled "Decision Processes in Water Quality Management" was prepared in partial fulfillment of the scope of the research study "Decision Processes in Water Quality Management", performed under Contract No. 14-31-0001-3163 of the Office of Water Resources Research of the Department of the Interior. A related study, "Systematic Analysis of the Management Effectiveness of the Water Quality Control Board System of California", was conducted under Contract No. 14-01-0001-1489 for the same agency, and a summary report, entitled "A Dynamic Model of Water Quality Management Decision-Making" was issued in May of 1970. The authors of the current report are Dr. Richard M. Males and Dr. William E. Gates, of the Engineering-Science Research and Development Laboratory, Oakland, California.

Submitted to

Office of Water Resources Research
Department of the Interior

Final Report
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Initiated 15 December 1969
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We have only
been taught
one solution...





We are Content...



and within our habits,
and sure our gods will prevail.

Our children are
secure

in the knowledge
that we have solved
the problems
of their world.





SEE out way clearly,
and we have made our choices.



As a consequence of the nature of this study, in which assessments and judgements relating to individual and group behavior have been made, the researchers gave a great deal of attention to the process of performing such research, in particular with regards to the point of view which the investigators of a social system hold, the biases which they inject into the study, and the integrity of the reporting of the study. The concept of "givens" and "system boundaries" was utilized to express the researcher's perspective; the givens are those unquestioned, often unarticulated, postulates about "how things work" which condition one's view of a system, e.g., "progress is good", "man must survive", etc. These givens, in turn, influence the boundaries that are perceived to exist when a particular subsystem of society is viewed; the boundaries set for a system often imply that anything inside the boundary is susceptible to change and manipulation, while those things lying outside the boundary are not, i.e., all system variables other than random variables lie within the boundaries.

The application of this concept to social system research has led the investigators to the belief that, in order to properly examine a social system, the boundaries of the system as seen by the researchers must at least include the boundaries of the system as seen by the participants in the system. That is to say, the social system must be viewed in a "larger" context. Since the givens that are held tend to determine the system boundaries, it follows that the investigators must hold different (and perhaps less constraining) givens than those observed to be held by the system. Further, in order that the research process be reported accurately, the investigators should state both their own givens, and the apparent givens of the system; only in this manner can the context in which the research was carried out be assessed by third parties.

The apparent givens of the air quality control decision-making process in California, and the associated system boundary, seem to revolve around the faith in economic and technical solutions to environmental problems. The "solution set" for environmental problems lies in the region of obtaining sufficient money to eliminate the apparent effects of environmental degradation. The givens preclude a perception of "technological solutions" bearing within them the seeds of future problems, and seldom confront the "growth" and "dominion over nature" ethics.

The givens of the researchers have evolved from a body of knowledge and theory in the fields of ecology and social sciences, leading to two basic concepts:

The environment is a continuously degrading, dynamic, feedback-oriented system (in the ecological sense), with human interventions principally accelerating or decelerating the rate of degradation, but never, in fact, reversing it.

- Social systems may be viewed as patterns of conflict/cooperation dynamics between different individuals/groups/interests, with no intrinsic "good" or "bad" groups or objectives.

These two concepts, which may be taken as the researchers' articulated givens, lead to two further postulates about environmental management:

- Maintenance of minimum degradation rates for the environment simultaneous with sustained economic growth for the social system are incompatible objectives.
- Any "solution" to environmental problems, in the sense of minimizing societal-caused degradation, must be viewed as involving behavioral modification of the present patterns of dealing with the environment.

Thus, the system boundary does not preclude other forms of human organization than the one currently in vogue in the western industrialized world, and the "solution set" for environmental problems lies principally in the realm of modification of behavior and social organization as the basis, with economics and technology as dependent variables.

It is apparent, then, at least to the researchers, that the system boundaries of the system itself fall within those held by the researchers; hopefully, this can provide for the needed perspective.

As a consequence of the essential difference in beliefs between the system and the researchers, and the potential, in social system research, for self-validating studies leading to pre-conceived conclusions, the concept of "integrity" of research in this field was explored. The fundamental idea relating to integrity derives from the given relating to conflict/cooperation dynamics; there is no such thing as objectivity - all decisions and procedures reflect in some measure the subjective preferences, goals, and biases of the individual and group. If the notion of "objectivity in research" is not retained, then the question becomes one of how to evaluate, as a third party, such "non-objective" research. The only viable resolution to this problem seems to be for the researchers to report their own objectives, biases, and pre-conceptions, as well as any and all political constraints on the study. Such reporting requires, on the part of the researchers, a clear concept of precisely what they are doing, and a means of formulating that concept to communicate with others. Accordingly, the idea of a "model", or "perception of how things fit together", a synthesis, is the organizing concept for this study - by specification of the model, the researchers can report their own biases, givens, system boundaries, etc., hopefully with sufficient detail to communicate this "model" to others. Utilizing this organizing concept, the study can be seen as the organic growth of a model; as new information

is received, it is processed, compared with the model, and the model revised or validated accordingly - any apparent gaps in the model guide the information-gathering process. This process of synthesis is an ongoing one - no model is ever definitive. In this light, much of the content of this report relates to the process of model development - a definitive statement, "This is the model", would be invalid almost immediately upon declaration.

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CHAPTER I

INTRODUCTION

BACKGROUND

The study described and discussed in this report was a consequence of, and an extension of, the study entitled, "Systematic Evaluation of the Management Effectiveness of the Regional Water Quality Control Board System of California", conducted for the Office of Water Resources Research of the Department of Interior (OWRR) by Engineering-Science, Inc., (ES) during 1969. This latter study, designated herein as the first-year study, and the results thereof, are described in a report entitled, "A Dynamic Model of Water Quality Management Decision-Making", dated May 1970.

SCOPE OF STUDY

The first-year study focused primarily on the decision-making process, including the decision-making structure, of a single agency, the Regional Water Quality Control Board, operating under the basic legislative policies of the Dickey Act which was enacted in 1948. This first-year study involved the development of theoretical and simulative models of the decision-making process of the single agency. These models were used in conjunction with basic behavioral data and systems techniques to: determine and define the decision-making process of the agency; characterize the behavioral characteristics of the agency; determine and delineate the principal elements and interrelationships of the decision-making process; and determine the manifestations of the decision-making process on the control and/or reduction of water pollution.

At the time the proposal was prepared for the present study, this time being prior to the completion of the first-year study, it was anticipated that it would involve an expansion of the focus of the first-year study to include multi-jurisdictional and multi-agency factors in the water quality management decision-making process. Additionally, the results of the first-year study and the expanded study were to be used to develop a "training program" for individuals involved in multi-jurisdictional, multi-agency water quality management decision-making processes. However, the nature of the first-year study and the results thereof were at such variance with what had traditionally been done in the arena of agency evaluation, and with what had been expected in the context of public administration, that there was real concern in several quarters with regard to the validity, applicability, and implications of the first-year study. Thus, the scope of the present study had to be modified to be an explicit extension of the first-year study so that some of these concerns could be allayed. Other modifications in the scope of the present study were made because: it was deemed inappropriate to

delve too deeply into the internal decision-making process of "sister" Federal agencies of OWRR; the Porter-Cologne Act superseded the Dickey Act as of 1 January 1970 in the area of water quality in California; personalities were playing an increasingly important role in water quality management in California; and the role of the Federal agencies became increasingly undefined as the study progressed due to the then impending creation of the Environmental Protection Agency.

Given the preceding factors, the focal point of the present study was shifted to the examination of an environmental decision-making system in a transitory state as it evolved from the autonomous Regional approach studied in the first year to some new, as yet undefined, "steady-state". The basic approaches used in the study, then, were as follows:

- The California Water Quality Control Board System was treated as a system in transition, from one "steady-state" Regional approach under the Dickey Act legislation, to some new mode of operation under the Porter-Cologne Act.
- The investigation of the system was carried out under the guiding precept of development of a "model", both conceptual and computerized, of the manner in which the system appears to function, and the utilization of this model to attempt the prediction of some of the "steady-state" characteristics of the present structure of organization of water quality management decision-making. To this end, interview data, case histories, and documentary information were obtained and analyzed to extract the basic behavior patterns that the system exhibits. The perceptions of the system thus acquired were continually used to re-evaluate and revise the investigators' "model" of the system.
- With the concept of models in mind, the idea of "training" evolved into the idea of clarifying and enhancing, for each participant in the water quality management decision-making process, his own and other peoples' models of the system, and areas in which the models conflict, the type of conflict, and regions in which such models are compatible. This idea of "training" was realized, in part, through the design and conduct of a Role Awareness Program (RAP) for members of the various Regional Boards in California.

FORMAT

The format of this report includes both written and graphic statements of concepts, which, it is hoped, will create a more complete view of the effort than would a written format alone. This chapter has dealt with some of the fundamental underlying philosophies and development of

the research. Chapter II presents a summary of the approaches and results, together with the principal conclusions of the study. In Chapter III, data development and analysis of behavioral data, together with an over-view of the current state of water quality management decision-making in California, is discussed. The theoretical and descriptive computer models of water quality management (WQM) decision-making are presented in Chapter IV, together with results and conclusions. The Role Awareness Program design and conduct is described in Chapter V, and Chapter VI presents comments on social system research in environmental management. Conclusions and Comments are found in Chapter VII.

ACKNOWLEDGEMENTS

The above efforts were carried out within the Environmental Systems Dynamics framework developed and employed by Engineering-Science, Inc., for assessing resource management objectives, activities, and functions. General Behavioral Systems, Inc., a behavioral sciences consulting firm, acted as subcontractor, conducted the major portion of the interviews and designed the role-playing exercise and evaluation for the RAP. Upon review of the draft of this report, representatives of General Behavioral Systems expressed the desire to be disassociated from the term "researchers" as used in the report, inasmuch as they disagree with many of the statements relating to the feelings/objectives of the researchers, in particular with regard to the Role Awareness Program, which they consider to have been a "success". General Behavioral Systems is not responsible for any of the statements made in this report, which is the product of the listed authors, who do wish to acknowledge the services of General Behavioral Systems during the course of the study. A great number of people cooperated with the investigators during the conduct of this study, and their assistance is gratefully acknowledged, with special recognition being due to the following:

Mr. Kerry Mulligan, Chairman, State Water Resources Control Board

Mr. Jerome Gilbert, Executive Officer, State Water Resources Control Board

Mr. Ray Hertel, Executive Officer, California Regional Water Quality Control Board, Los Angeles Region

Dr. Glen Fulcher served as project director for the Office of Water Resources Research. Principal investigators for the study were Dr. Richard Males and Dr. Barry Jensen. Mr. Junius F. Walker was the project leader for the General Behavioral Systems (GBS) input to the study. Mr. Roger Carey of GBS conducted and analyzed most of the interviews, and played a significant role in the development of RAP. Mr. Donald White, formerly of Engineering-Science, Inc., (ES) participated as staff behavioral scientist early in the study. Mr. W.O. Maddaus of ES developed

the theoretical computer model. Cover and interior art work for this report was designed and executed by Mr. James Price of ES. Appreciation is extended to Mrs. Joyce Rawls who provided editorial assistance and typed the draft and final version of this manuscript. The study was supported in total by a grant from the Office of Water Resources Research, administered under Contract No. 14-31-0001-3163.

CHAPTER II

SUMMARY AND CONCLUSIONS

WATER QUALITY MANAGEMENT IN CALIFORNIA

On 1 January 1970, the Porter-Cologne Act, a significant revision of the California water quality legislation, took effect. Prior to that date, the Regional Water Quality Control Board System, operating principally under the Dickey Act legislation of 1948, was a system of autonomous Regional Boards, essentially responsive to local vested interests. The Regional Executive Officer (EO) was the key personage in the decision-making process. The Porter-Cologne Act provides a means for a shift in emphasis to State-centered control of policy-making, with considerably less autonomy on the part of the various Regional Boards. Although the new legislation itself does not specifically provide the formal structure of the decision-making process, it has made possible the construction of such a State-centered informal structure by a few key participants in the decision-making process, who have taken an "activist" role. This "symbiosis" between the structure and individuals within the structure is a basic feature of the decision-making process in water quality management in California as currently constituted.

Inasmuch as the "normal" character of the decision-making process is still evolving under the new provisions of the Porter-Cologne Act, the current state of the decision-making process is considered as a "transient" condition. A major goal of the research was to examine this transient state, and from it predict features of the eventual "steady-state" decision process. The early phases of the transient state, during perhaps the first six months of 1970, were marked by confusion and some hostility on the part of the Regional Boards toward the State Board, as it began to exercise a considerably stronger role in the decision-making process. This period of confusion has subsided, and there appears to be a tacit acceptance, on the part of the majority of Regional Boards, of the new role of the State-level organization in the decision-making process.

Drawing upon observations of the transient state, the following are projections as to the probable steady-state character of the water quality management decision-making process in California.

- The State Water Resources Control Board, (State Board) with administrative control of grants which can total up to 80 percent of construction costs for pollution control facilities, can, in large measure, dictate the character of water quality control by municipalities; enforcement measures can serve to dictate industrial water pollution control activities.

- "Planning" will be the vehicle and channel by which control is achieved and money funneled to the communities; through approval of plans and criteria therefore, the State Board can, in effect, specify the manner in which pollution control requirements are to be met, a departure from previous practice in which only the desired outcome (effluent or receiving water standards) was specified.
- The individual Regional Boards will become more technical/implementation oriented, less "political", and less concerned with policy-making. Although theoretically "autonomous", they will operate as technical/implementation arms of the State Board.
- The major portion of inter-agency decision-making will take place at the State level rather than at the Regional level; many Federal agencies with jurisdiction over aquatic environments will rely on certification by the State agency prior to issuance of permits, etc. - which will be handled through the State Board. During the transient period, Federal activity in decision-making has been minimal, most probably due to the reorganization of the Federal administrative structures into the Environmental Protection Agency.
- There is a strong possibility that the State of California will develop a unified pollution control agency, dealing with broad-scale environmental protection, incorporating many of the functions and philosophies of the present water resources control policy.

It is not apparent at this point how the new steady-state decision-making process will deal with the following points:

- The role and function of the Regional decision-making: the Regional Boards do not have any clearly defined function or responsibility at this point, inasmuch as the policy-making arena has been preempted by the State, and the technical arena is handled by the staff and executive officer. Further, the apparent overriding priority for "environmental protection" as imposed by the State Board, effectively prevents the Regional Board from acting as an integrator of all Regional interests.
- There does not appear to have been any examination, at this point in the decision-making process, of the economic shifting of the cost burden as a result of pollution control and enforcement activities, and such concerns are expressly not taken into account.

The system, and associated decision-making process, has apparently not formulated the following questions:

- How are priorities between differing social objectives to be determined (i.e., pollution control vs. poverty eradication, urban problems, etc.)?
- Is the achievement of the technical objectives for water quality control equivalent to the achievement of the social objectives underlying the technical concerns (do water quality standards, in fact, protect beneficial uses of the waters)?
- What is the role of non-technological (behavior and attitude modification) approaches for water quality control?
- How will the various "public" interests be integrated in the forthcoming planning process?
- Can the present mode, philosophy, and structure of water quality control operate independently of the specific personalities now involved?

STUDY OBJECTIVES

This particular research project was conducted in an arena involving, in effect, two clients. The formal client was the Office of Water Resources Research of the Department of the Interior which provided the project funding. The State Water Resources Control Board of California is a client by virtue of the fact that Engineering-Science, Inc. conducts a significant portion of its business in California, and the "goodwill" of the State Board is a valuable asset in the conduct of this business. It is an interesting speculation as to precisely how Engineering-Science finds itself in the position of evaluating a group on which it is dependent. The researchers were fully aware of this dubious position. However, it is believed that the nature of the preceding study and its associated report entitled A Dynamic Model of Water Quality Management Decision-Making documents that the evaluative faculties of the researchers were not unduly biased by the study environment. In any case, given the number of entities bearing a vested interest in the study, it is necessary to identify four sets of objectives for the study; a set of objectives for each client, OWRR and the State Board; a set of objectives for Engineering-Science, Inc., and finally, an objective set for the researcher themselves.

Objectives - Office of Water Resources Research

- Satisfy OWRR as to the results and methodology developed and applied in the first-year study of the decision-making process.

- Develop a model of the State-wide decision-making process for water quality management in California.
- Develop and test a "training" program into a transferable package, applicable in contexts other than that of California.

Objectives-Engineering-Science, Inc./State Board Interface

- Introduce no "perturbations" into the transient phase of the decision-making process (i.e., don't "make waves" for the State Board).
- Conduct the Role Awareness Program exercise in accordance with the State Board goals (i.e., no exploration of State-Regional problems).

Objectives-Engineering-Science, Inc.

- Establish the company's capabilities and capacities in the field of social systems research for environmental problems.

Objectives - Researchers

- For some, the development of a saleable technique.
- For others, the opportunity to "do a social system model correctly", and to interact with and enhance the perception of individuals directly concerned with implementation of environmental protection measures.

Altruistic Objectives (pre-conceived desires for the results of the research)

- Encouragement of a judicial review of the bases for environmental legislation.
- Definition of clear-cut responsibility throughout the water quality decision-making system ("visible" decision-making processes).
- Encouragement of total-problem based, rather than piecemeal approaches, to environmental control.
- Encouragement of recognition that aquatic environmental protection is involved with rates of change and not absolute levels.

APPROACH

The fundamental approach was to hold a "model" of the system at all times, using systems analysis and behavioral science techniques to articulate, expand, modify, and explain the model over time. That is, the concept of a "model" was used as the unifying principle for the entire study; data-gathering efforts were viewed as information sources for clarifying or revising the "model". The various computer simulation models were further viewed as: (1) ways of being explicit about the conceptual model of the system; and (2) tools for obtaining insights into the way the currently-held conceptual model operates. The Role Awareness Program, as initially conceived, was a workshop wherein participants in the water quality management decision-making process could explore and clarify their own models, and attempt to understand the models held by others.

Three basic tools/techniques were utilized in the study:

- *Data Development and Analysis* - More than 100-in depth, semi-structured interviews, lasting on the average, one hour, were conducted with key individuals concerned with water quality representing a wide range of agencies and interest groups. This data was analyzed, both formally and informally, to develop (together with other sources), a picture of the current status of water quality management in California, and formal attitude profiles of various agencies/interest groups with regard to water quality management.

Selected "case histories", representing controversial, high-awareness situations, were followed over time, both through the media and through informal contacts with the participants in the case.

- *Development of Computer Models* - Two different computer models of decision-making systems were developed and utilized. The first model, termed the "theoretical" model, is based on a representation of the abstract problem of decision-making in a two-party context, where one party holds a dominant position over the other party. The setting is similar to that between the Regional and State Boards, but the model is "theoretical" in the sense that it is not based on a behavioral study of an actual situation.

The second model developed, termed the "descriptive" model, is an extension and modification of the model of Regional Board decision-making developed in the first-year study, and is based on the behavioral study of the prototype. A basic feature of the model is the three-party interaction between the State Board, Regional Board, and Regional Executive Officer.

- **Role Awareness Program (RAP)** - The concept of RAP evolved over time as an alternative to "training" of participants in the decision-making process. The over-all design, of which a portion was implemented in this study, is intended to transfer some of the insights/ideas/conclusions which developed from a systems/behavioral study of the decision-making process in water quality, to participants in the process. The over-all design incorporates a number of techniques, including role-playing, exploration of communication and small-group dynamics, the utilization of the idea of models, and concepts of feedback and dynamic systems. Due to a number of constraints, only the role-playing portion of the design was implemented to a significant degree with participants in the decision-making process.

The role-playing portion was structured as a three-hour workshop, in which a simulated Regional Board meeting took place, and participants were able to "try on" different roles from the ones that they normally pursue, and thus receive feedback on how they and others perform.

RESULTS

Results of this study take the form of:

- A descriptive analysis of the principal features and philosophies of water quality management in California during 1970.
- Attitude profiles of opinions with regard to water quality management on the part of different groups and agencies.
- Results of the computer runs with the theoretical and descriptive models.
- Experience with the design and conduct of RAP, and evaluation, by the participants, of the role-playing exercise.
- Experience in the techniques of conduct of research into social system behavior, social system modeling, and the reporting of such research.

The descriptive analysis and attitude profiles are discussed in detail in Chapter III of this report. Principal features of the descriptive analysis have already been noted in the summary section at the beginning of this chapter. Attitude profiles, in general, show strong unanimity as to the basic philosophies of water quality management, and divergence with regards to the operational aspects of administration. An interesting feature of the attitude profiles is that, in general, those

individuals expressing the strongest opinions are those considered to be the most effective and, in fact, hold key positions in the water quality management structure in California.

The theoretical and descriptive model structures and results are described in detail in Chapter IV. The theoretical model is designed to show the interaction between a subject and dominant party under three possible modes of attitude change: negotiation between the subject and dominant parties; education of the subject party by the dominant party; and pre-emption, in which the subject party is forced to perform in a certain manner by the dominant party. With these three alternatives as possibilities, that of education proves to be the most favorable choice for the dominant party where possible.

The descriptive model is designed to characterize the current features of the decision-making process for water quality management in California. As in the first-year study, the only meaningful measure of effectiveness of a decision-making process is the reduction in over-all pollutional levels in the aquatic environment. Some typical results obtained from the model are:

- Over the long-term, present control philosophies can reduce the current high level of pollution, but cannot prevent a re-growth of pollution after the initial reduction.
- The two limiting factors causing re-growth are the effectiveness of control technology (which reaches an eventual maximum), and the increasing economic growth rate over-all, which causes a long-term stress.
- Occasional pre-emption by the State Board when necessary, combined with education of the discharger to new behavior patterns, is the optimal control mode under the present system.

The RAP design, conduct, and evaluation procedures are described in Chapter VI of this report. Basic results from the RAP include:

- A general feeling on the part of the participants that the exercise was worthwhile.
- Strong responses on the part of the participants - those that did not find it of value found it "a total waste of time".
- A strong focus, on the part of most participants, upon the accuracy of the process of simulating a Board meeting, rather than a focus on the process of assuming roles - typical responses included - "That's not the way we do it at our Board meetings".

- Dissatisfaction, on the part of the researchers, with the relative shallowness of the accomplishments of the role-playing exercise - most of the basic factors in decision-making in California were untouched.

The difficulties, pleasures, and problems associated with performing the research are discussed in Chapter VI. Probably the most significant result of the experience of performing this research is the perception of just how difficult it is to conduct and report this type of work with integrity - integrity in the sense of being true to one's own biases. The conventions of research reporting, the widely differing perspectives of the readers of this report, combine to make the problem of communicating the total experience of such research a difficult one. The only option that appears viable in this situation is for the researchers to make some kind of statement of their own philosophies and biases - the context, intellectual and emotional, in which they carried out the work. Certain specifics of this context are detailed in Chapter I.

CONCLUSIONS

Two warnings prefaced the conclusions of the first-year report; their essence is repeated below, and a third warning added:

- Any research, and particularly social system research, presents in some manner the bias of the researchers.
- Criticism of a system is a different matter from criticism of individuals within the system.
- It is one thing to sit outside of a system, observe it, criticize, analyze, and draw conclusions. It is another thing to be involved within that system, making personal and political decisions each day. Trade-offs, half-measures, compromises, and inconsistencies are the order of the day in the real world. If the outside observer has any function at all, it is to reflect back upon the system some external perspectives, to provide feedback, and raise questions. The researchers then perform this reflection function with the knowledge that they are "disengaged" from the system.

With this in mind:

- It appears feasible to analyze a social system and project steady-state behavior.
- The State Water Resources Control Board has been successful in centralizing power for policy-making; the manner in which the power is administered in certain conflict situations remains to be seen.

- A serious court test of the Porter-Cologne Act is important to define the current limits of authority of the control agency.
- The system appears to believe in its own efficacy; its givens have a strong "good-bad" duality implicit within them.
- Personalities play a key role in water quality management decision-making in California. There is a wide range of skill and perception among the individuals involved in water quality decision-making.
- The decision-making process appears well-g geared to handle most problems traditionally associated with water quality control from a short-term point of view. The long-term implications of the control activities and philosophies do not appear to have been addressed by the system itself.

RECOMMENDATIONS

- The first order of business is definitely a court test to define the discretionary powers of the administrative agencies associated with environmental control (at present, for water quality control in California, most limits of authority seem to be self-imposed - the system is apparently "testing" its own boundaries).
- Assuming that the present authority is, in fact, validated by the courts, and holding the apparent givens of the State Board:
 - .. The State Board should act to keep awareness of water quality control problems high - in essence, it should discover new "crises" from time to time.
 - .. The Regional Boards should be developed as technical arms of the State Board, acting within clearly defined boundaries and procedures. Inasmuch as there is little function presently served by the nine-member Regional Boards, some definition of the role of these Boards should be developed, and the size, membership, and duties of the Boards adjusted accordingly.
 - .. The State Board should seek broader environmental control authority, for example with regards to the area of land use planning, as it may effect water quality considerations.
 - .. The State Board should encourage the formation of regional "environmental plans", incorporating non-aquatic considerations as well as traditional water and sewage master plans.

- .. The State Board has the potential to encourage regional co-operation, by demanding that plans be formulated on a regional basis, in the same manner in which the Federal government has acted (due to the strong Federal stress on regional planning, such an eventuality is likely in any case).
- .. An important aspect of the State Board's functioning should be the establishment of socio-political structures for water quality control and development of basic technology which will endure after the current high level of environmental awareness subsides.
- .. Inasmuch as there is presently a strong interrelationship between the structure of the decision-making process and the individuals who, in fact, motivate and direct this process, the State Board should either seek out high-calibre people and bring them into the system or attempt to establish a system "independent" of the quality of the people within the system.
- Holding the givens of the researchers, the following recommendations are made:
 - .. The State Board should determine the maximum acceptable rate of degradation of the environment in a given region, and then allocate and constrain the use of the aquatic resource in a region to the Regional Board at a level which maintains that rate. The Regional Board should then have the authority to allocate and constrain the resource "optimally" within its own region, taking into account regional politics, economic priorities, etc.
 - .. The Regional Boards, under this structure, would of necessity become true decision-makers, in the sense of choosing between alternative courses of action, which they do not do with any great frequency at present.
 - .. It is important to perform research into the economic cost-shifting resulting from pollution control activities, in order that multiple social objective planning may have the necessary information upon which to base decisions.
- Assuming that the courts do not validate the discretionary powers now in practice, efforts should be extended towards passing legislation which does define the "rights of the commons" and provide a body of law which does have some meaning with regard to "ecological" realities.

CHAPTER III

WATER QUALITY MANAGEMENT DECISION-MAKING IN CALIFORNIA

INTRODUCTION

The objective of this chapter is to present the data development and analysis techniques used in this study, and the resultant observed characteristics of the current transient phase of water quality management decision-making in California. The characteristics of the prior "steady-state" behavior of the decision-making system are also summarized, based on the detailed report of the first-year study.

The guiding principle for data development was, at all times, the maintenance of a conceptual model of the decision-making process. At the start of the research effort, the initial model held was that developed in the first-year study. Data on system response and attitudes was needed to check the validity of this model under transient phase conditions - when discrepancies were found between the observed prototype behavior and that consistent with the conceptual model, the model was revised. In this manner, the continual influx of new data relative to the prototype system provided for a continual validation and evolution process for the conceptual model. Thus, at any given time during the research, the conceptual model represents the integration of the data flow-analysis-validation-revision process to that time.

DATA DEVELOPMENT

The basic tool for raw data development was the in-depth, semi-structured interview. Over 100 of these interviews, lasting on the average of one hour, were conducted. Two interview series were scheduled; the first series consisted of interviewees in the formal inter-agency decision-making structure, i.e., Regional Boards, State Board, Department of Fish and Game, Corps of Engineers, etc. From information received in this series, a second series of interviews with individuals participating informally (Sierra Club, League of Women Voters, various dischargers) in the inter-agency decision-making structure were conducted. Most interviews were tape recorded (except in portions where the interviewee requested "off the record" statements) and transcribed. Subjective impressions on the part of the interviewer were noted separately.

Format for the interview varied somewhat depending upon the individual(s) being interviewed, but the following general structure was usually observed:

- Explanation of study, purpose of research, permission to tape record, etc. (5 minutes).

- Series of formal questions, for the record, to place respondent in context in the decision-making structure (i.e., What are your agency's goals with respect to water quality management?, How does your agency interact with the Regional (State) Board?, etc.) (20 minutes).
- Series of questions relating to changes brought about through the introduction of the Porter-Cologne Act, the action of personalities within the system (i.e., Are the enforcement provisions of the Porter-Cologne Act effective?, Do personalities influence the decision-making process significantly?, etc.) (20 minutes).
- Open-ended questions and discussions relating to over-all philosophies, approaches to water quality, political influences, etc. (15+ minutes).

This raw data base was then analyzed both formally and informally; the informal analysis consisted of review of all material (including the formal analysis) with the objective of developing the conceptual model structure for water quality management decision-making; the results of this review are expressed in two forms - the structure of the computer models, and the descriptive analysis presented in a later section of this chapter. The formal analysis consisted of the reduction of interview data to attitude profiles. Fifteen statements relating to water quality management in California were developed. Each interview transcript was then examined by a behavioral scientist, and his subjective impression of the respondent's attitudes towards each statement was quantified in a linear scale from 1 (strongly agree) to 5 (strongly disagree). Accordingly, the 15 numerical rankings were taken to represent the attitude profile on the part of the respondent. These profiles were then presented graphically, and analyzed by various categories of respondents (according to the particular interest group or agency position held). The 15 attitudinal statements used for the profiles are presented in Table III-1 and a detailed analysis of the attitude profile studies follows.

ATTITUDE PROFILE ANALYSIS

The attitude profile analysis was devised as a means of obtaining comparative, graphic presentation of the views held by participants in the water quality management decision-making system. The 15 statements of Table III-1 were designed to indicate the principal views held by system participants. The first eight statements are essentially descriptive and philosophical in nature, relating to general principles of water quality management. The remaining seven statements are prescriptive in nature, dealing mainly with the operations and administration functions of the decision-making system. Most of the statements are self-explanatory; statements six and seven relate to whether or not the State and Regional Boards are seen to act as a unit (monolithic), or are perceived as composed

TABLE III-1
ATTITUDE PROFILE STATEMENTS

1. Personalities play an important role in water quality management in California.
2. There should be no difference among the regions with regard to the manner in which water quality management is handled.
3. The role of the Federal Government is presently limited.
4. The major barriers to the achievement of a clean aquatic environment are financial and technical.
5. It is possible to have economic growth with environmental quality.
6. The State Board is monolithic.
7. The Regional Boards are monolithic.
8. The enforcement procedures of the Porter-Cologne Act are effective in achieving compliance.
9. The State Board should play a leadership role in setting the context, priorities, and goals for water quality management.
10. A logical development under the Porter-Cologne Act is to abolish the Regional Boards and establish district offices reporting to Sacramento.
11. The State Board should take pre-emptive action when the Regional Board is slow to act.
12. The increasing independence of the Regional Boards is or would be desirable.
13. Under the new operations concept, the Regional Executive Officer tends to by-pass the Regional Boards.
14. There is political pressure on the Regional Board.
15. There are too many members on the Regional Board.

of individuals holding differing opinions (i.e., a negotiation process takes place within the Boards).

Each interview transcript was analyzed in the manner described below; composite scores for various agency groupings were obtained by averaging. Unless otherwise noted, the composite scores are not differentiated on the basis of position in the given agency; i.e., the composite profile for the State Board includes individual profiles for Board members, staff, and executive officer.

Data analysis was based on transcripts of tape recordings, notes taken, and impressions obtained during the interviews. Because the specific statements for the data analysis were not formulated until after the completion of the interviewing, much of the analysis was based on implication and the "tone" of the interview. The process was to answer all of the data analysis statements for an individual after reading the transcripts and notes from the interview.

Numbers were assigned for each statement and respondent based on the "tone" of the interview, responses to other relevant statements, and the interviewer's impression of the strength of the respondent's comments. A value of one was assigned if the respondent expressed strong feelings in the area of the statement or if it was believed, based on the respondent's other comments, that the respondent would have answered the statement in this manner. The numbers were assigned not so much on how strongly the respondent agreed with the statement but how strongly he felt about the content of the statement.

The numerical rankings do not represent direct answers on the part of the respondents to the 15 statements. They represent the researchers' opinion of the respondents' answers, for example: on statement one, if the respondent thought personalities were very important in the water quality management of California or if he referred more to people in the system than he did to such things as economics, the law, or events as influencing the system, it was determined that he thought personalities were very important in the system. A value of two was assigned if the respondent thought personalities were influential, but not of paramount importance, or if he referred to people and recognized the importance of other factors in water quality management in California. A value of three was assigned if the respondent had no opinion, or if an answer to the question could not be inferred since he did not refer more to people than other factors. A value of four was assigned if the respondent thought personalities were not too important or if he referred more to other factors, such as the law, economics, or other events, with occasional references to people. A value of five was assigned if he thought very strongly that personalities had little influence on the water quality management system or constantly referred to other factors in the system.

The attitude profile analysis was divided into five series. Profiles from Series I (Figures III-1, 2, 3, 4, and 5) represent the composite profiles from various agencies; the totality of responses have been used to develop an over-all view of the commonly held model of water quality decision-making. Series II profiles (Figures III-6 and 7) represent a detailed analysis of the profiles for the State Board members and staff. Series III profiles (Figure III-8) represent the profiles of individual members and staff of the San Diego Regional Board. Series IV profiles (Figure III-9) represent the executive officers of five of the Regional Boards. Series V profiles (Figure III-10) represent the Federal agencies interviewed. Additionally, a profile representing the model held by the researchers (Figure III-11) is included for comparison.

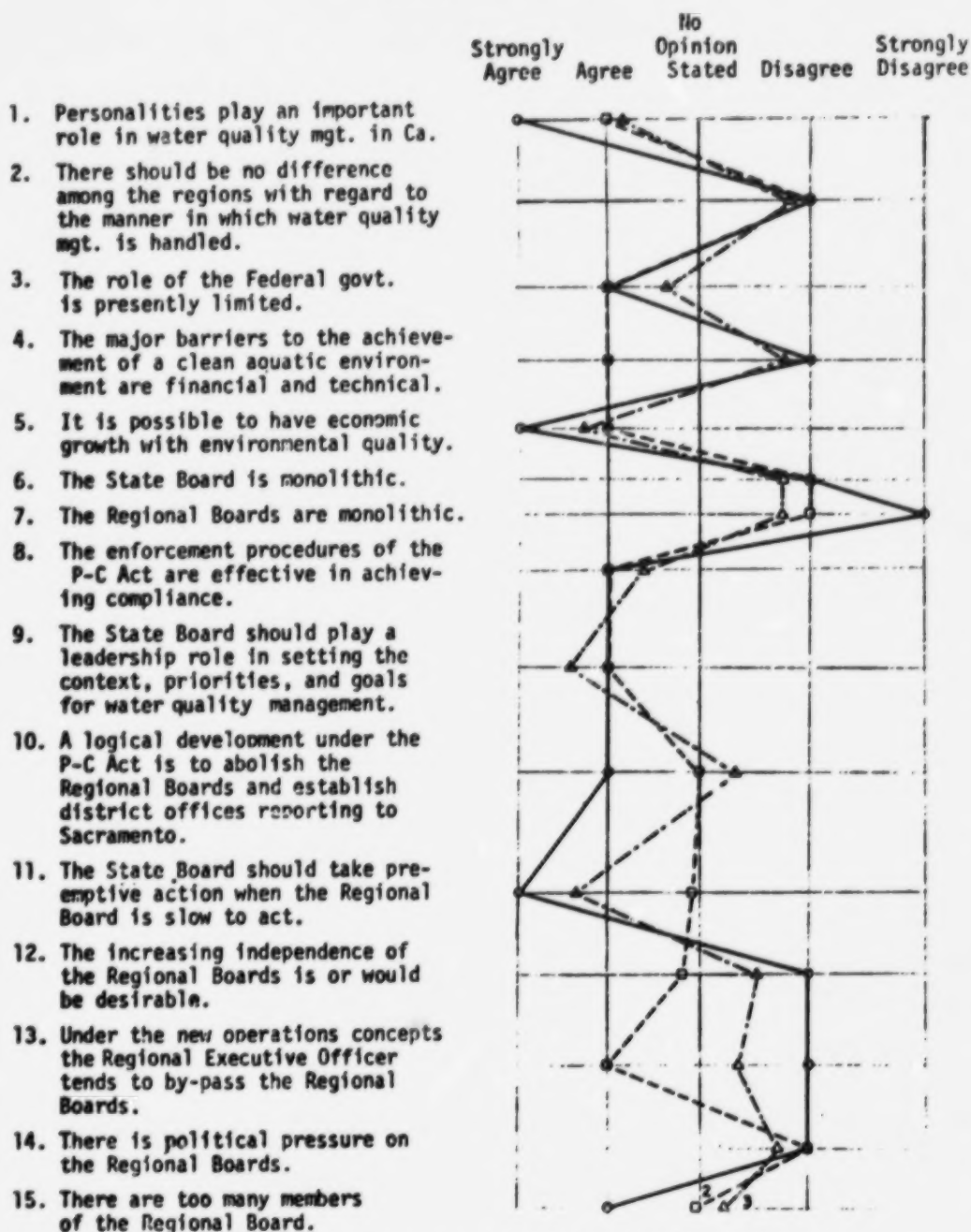
Series I

The general profile, essentially a normative one, suggests the following commonly-held view of water quality control in California.

The achievement of effective water quality control in California is within the grasp of the existing legislative and administrative structures. The combination of centralized state-wide leadership and recognition of regional differences (how this combination is to be effected is unspecified) is seen as the existing and proper channel. The force of personality of individuals within the structure is seen as important, and it is the general view that there exist internal differences of opinion within the Regional and State Boards. The Regional Executive Officers are seen as becoming more responsive to the State authority. It is generally held that the financial and technical resources to solve the problem do exist, and it is now a matter of changing attitudes such that these resources are, in fact, diverted to problem-solving activities. There is little recognition of current Federal roles, with the major thrust in California coming from the State itself. (Members of the State Board have expressed the desire to "always keep a step ahead of the Feds"). The most significant differences of opinion within the profile relate to the independence and autonomy of the Regional Boards, and the role of the State in enforcing its own concepts of water quality control by stepping in. Representatives of the "discharger" vested interest groups hold that the Regional Boards should be more autonomous, and that the State Board should not step in.

Comparatively, on the composite profiles, the San Diego Regional Board holds the strongest opinions of all the Regional Boards studied. It is generally agreed that economic growth and environmental quality are not dichotomous - in fact, the San Diego Board strongly disagreed, not unsurprisingly, because much of San Diego's recent economic growth has been directly related to the development of water-based recreation and tourism.

ATTITUDE PROFILES - SERIES I



Key: (1) Reporters; (2) Calif. Manuf. Assoc.; (3) Dept. of Fish and Game

ATTITUDE PROFILES - SERIES I

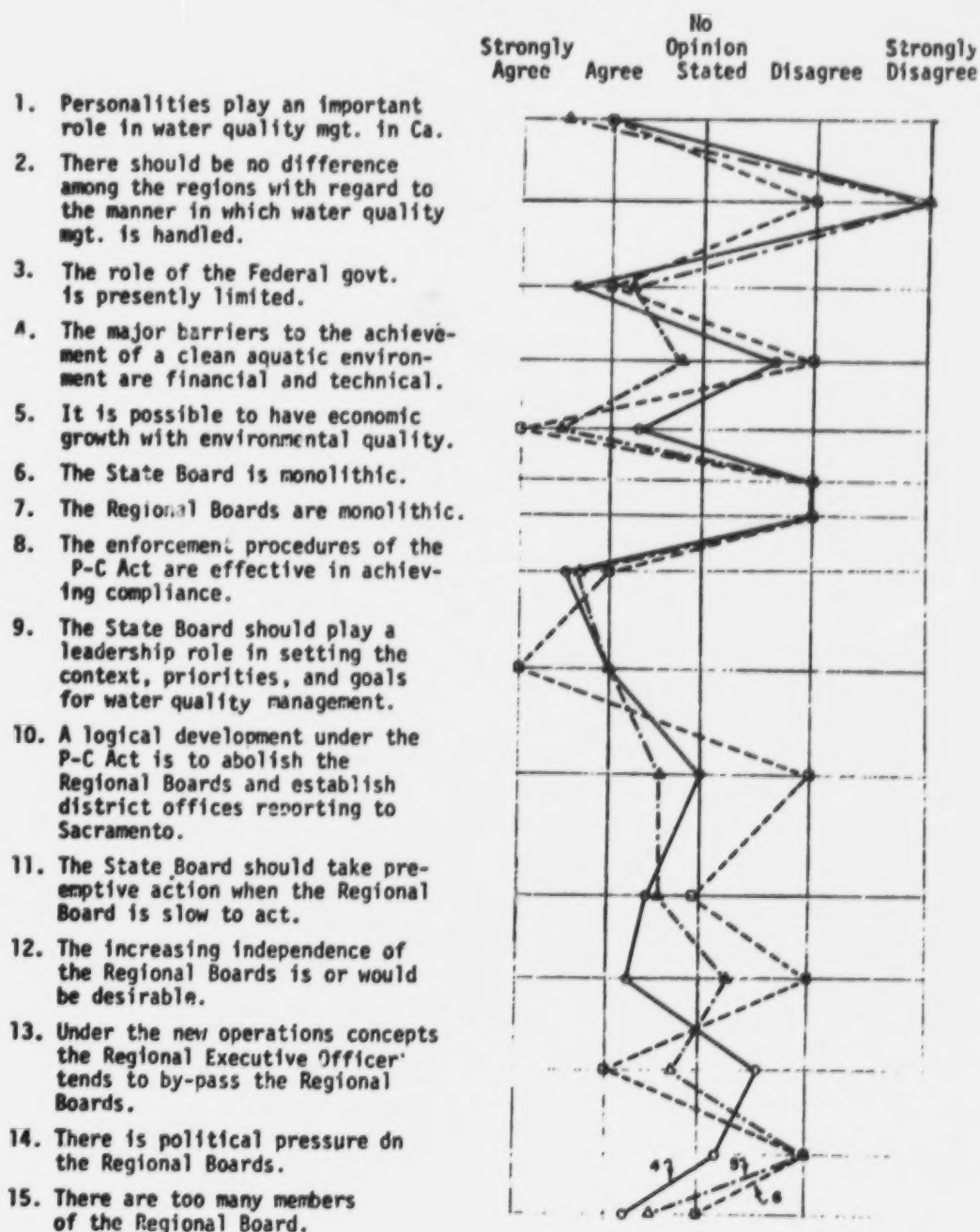
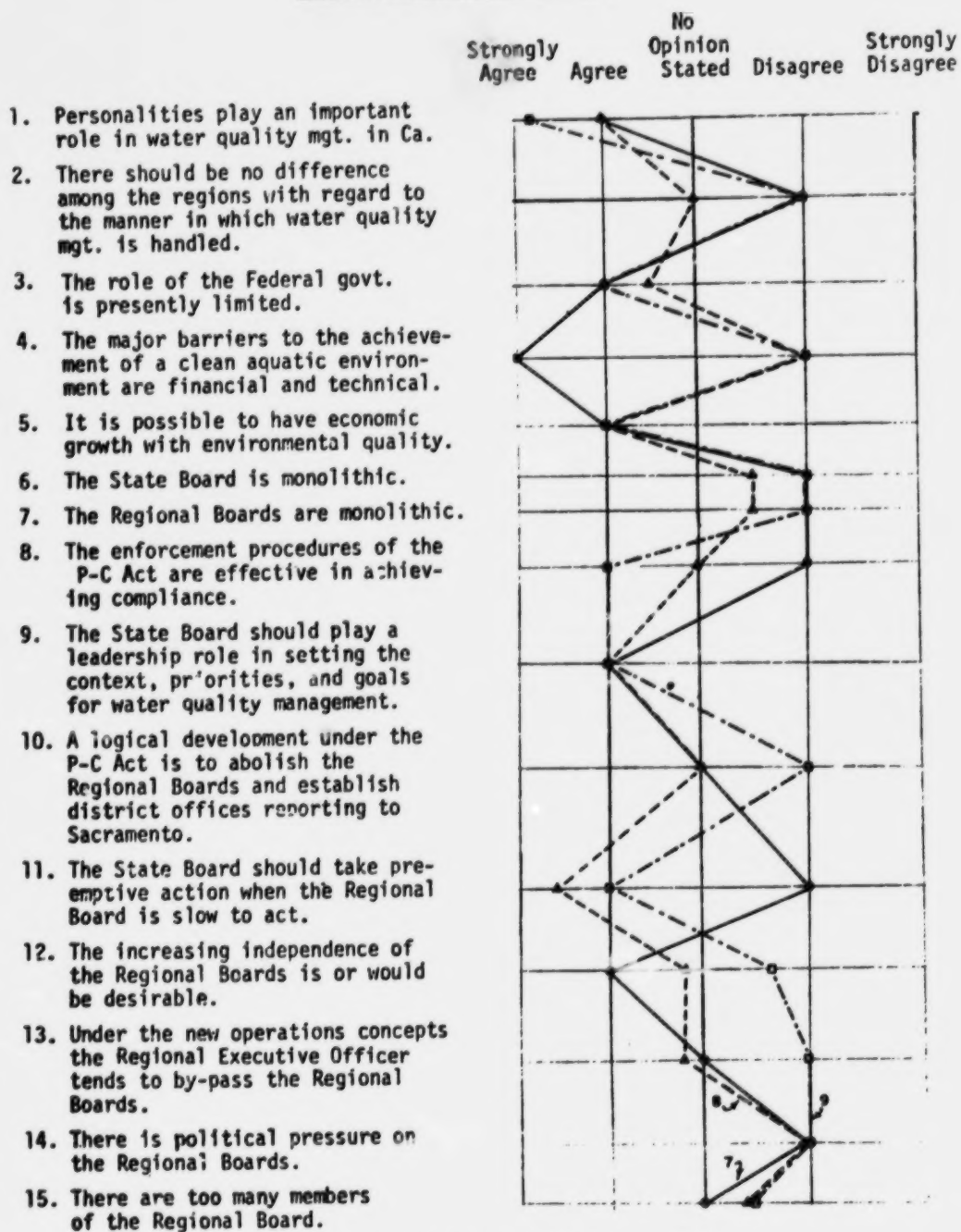


FIGURE III-3

ATTITUDE PROFILES - SERIES I



Key: (7) City of S.F.; (8) State Legislature; (9) Sierra Club

ATTITUDE PROFILES -- SERIES I

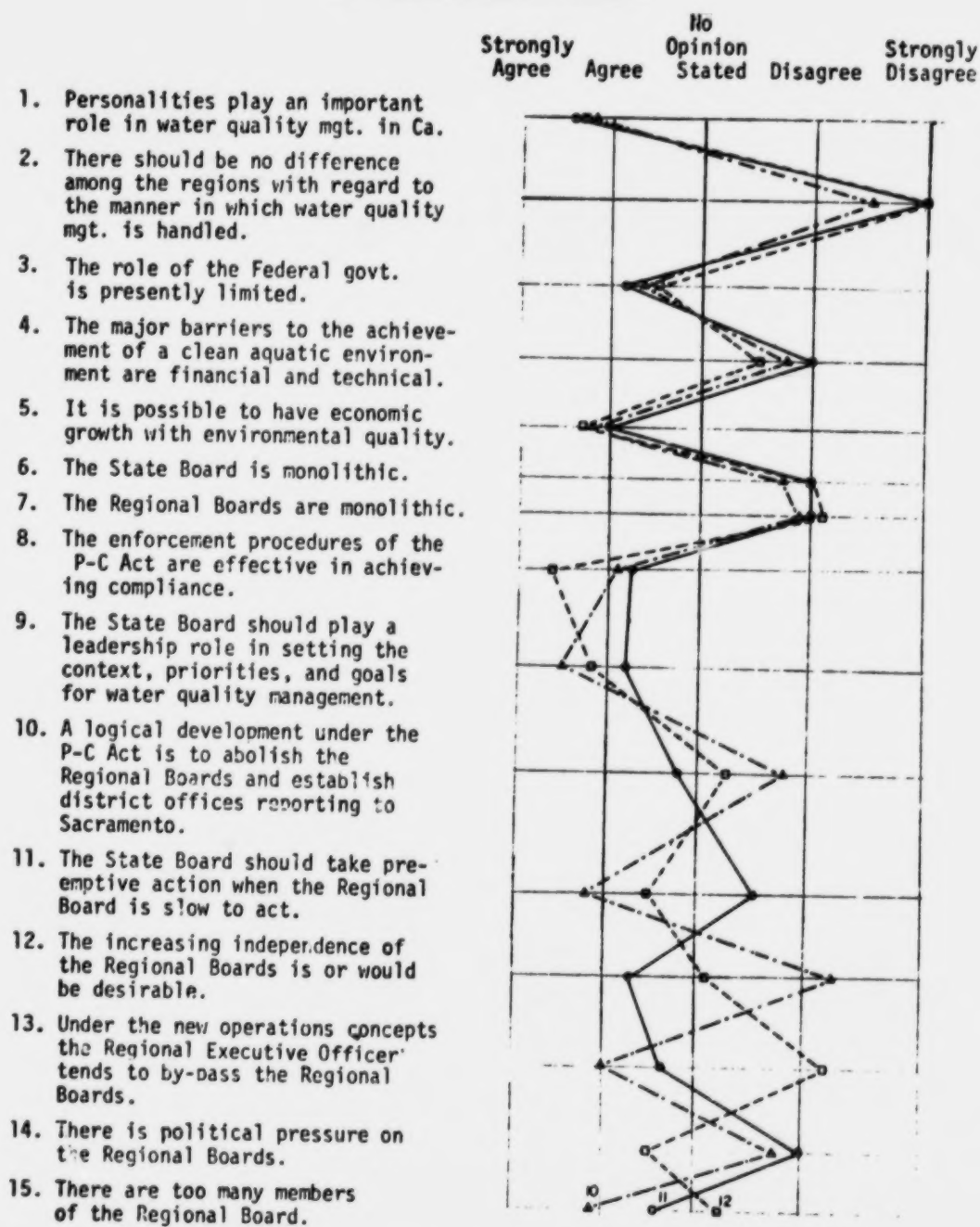
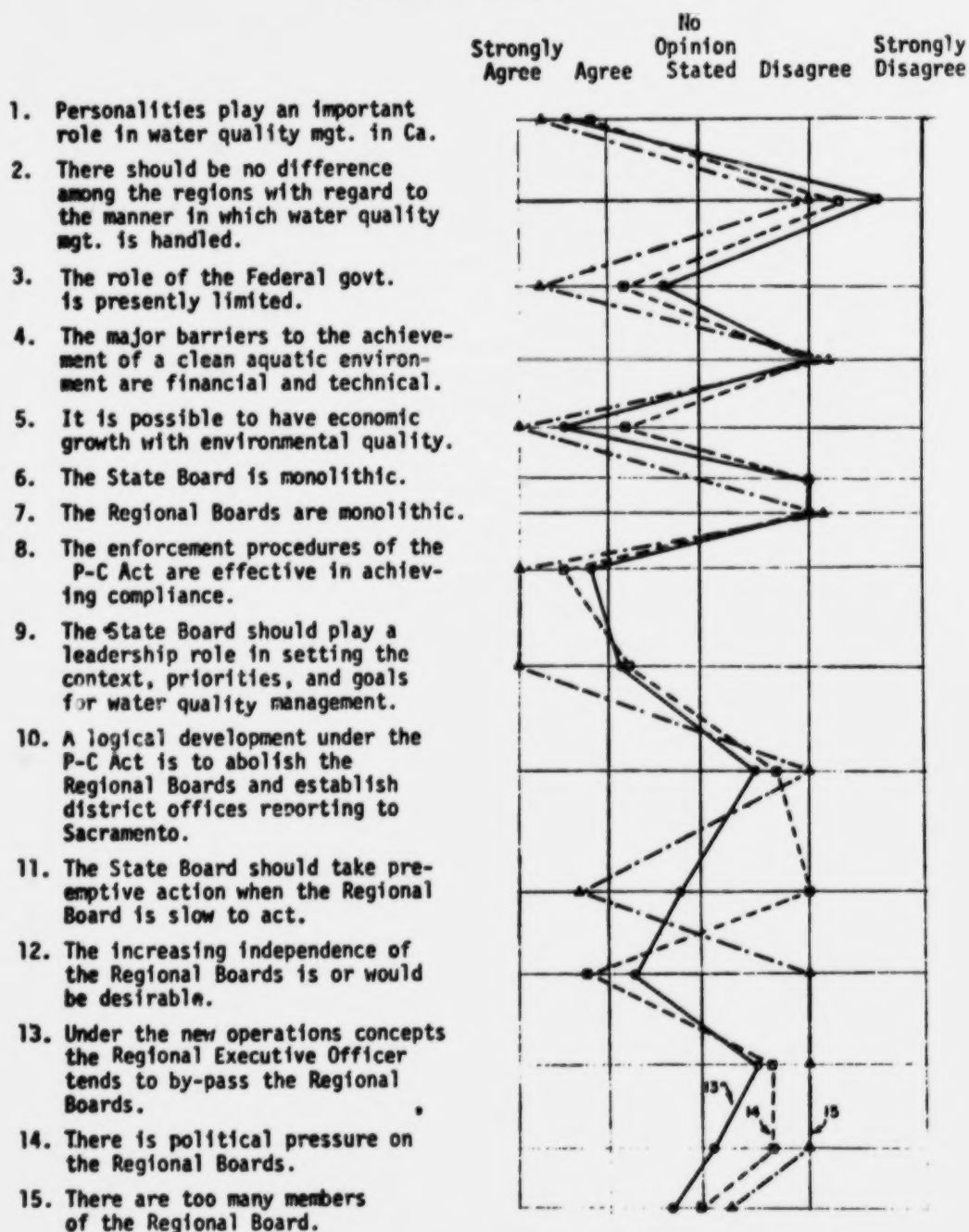


FIGURE III-5

ATTITUDE PROFILES - SERIES I



Key: (13) Lahontan Regional Board; (14) North Coast RB; (15) San Diego RB

ATTITUDE PROFILES - SERIES II
STATE BOARD MEMBERS

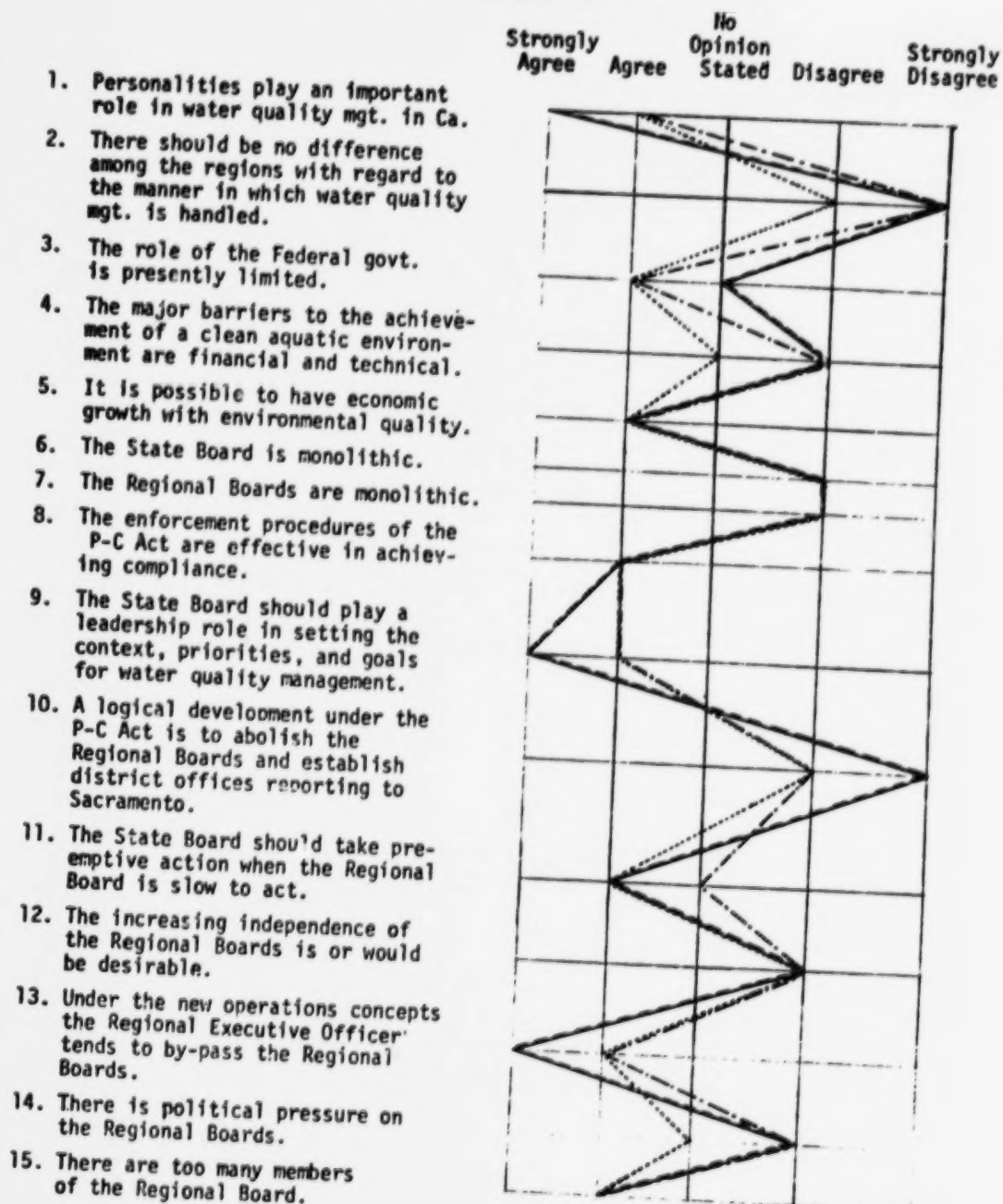


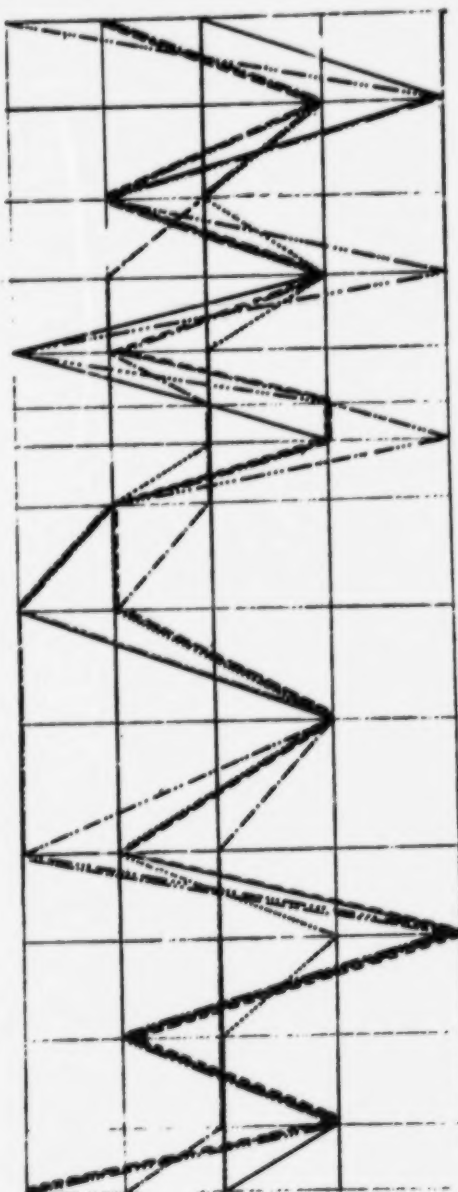
FIGURE III-7

ATTITUDE PROFILES - SERIES II

STATE BOARD STAFF

Strongly Agree Agree No Opinion Stated Disagree Strongly Disagree

1. Personalities play an important role in water quality mgt. in Ca.
2. There should be no difference among the regions with regard to the manner in which water quality mgt. is handled.
3. The role of the Federal govt. is presently limited.
4. The major barriers to the achievement of a clean aquatic environment are financial and technical.
5. It is possible to have economic growth with environmental quality.
6. The State Board is monolithic.
7. The Regional Boards are monolithic.
8. The enforcement procedures of the P-C Act are effective in achieving compliance.
9. The State Board should play a leadership role in setting the context, priorities, and goals for water quality management.
10. A logical development under the P-C Act is to abolish the Regional Boards and establish district offices reporting to Sacramento.
11. The State Board should take preemptive action when the Regional Board is slow to act.
12. The increasing independence of the Regional Boards is or would be desirable.
13. Under the new operations concepts the Regional Executive Officer tends to by-pass the Regional Boards.
14. There is political pressure on the Regional Boards.
15. There are too many members of the Regional Board.



ATTITUDE PROFILES - SERIES III

SAN DIEGO BOARD

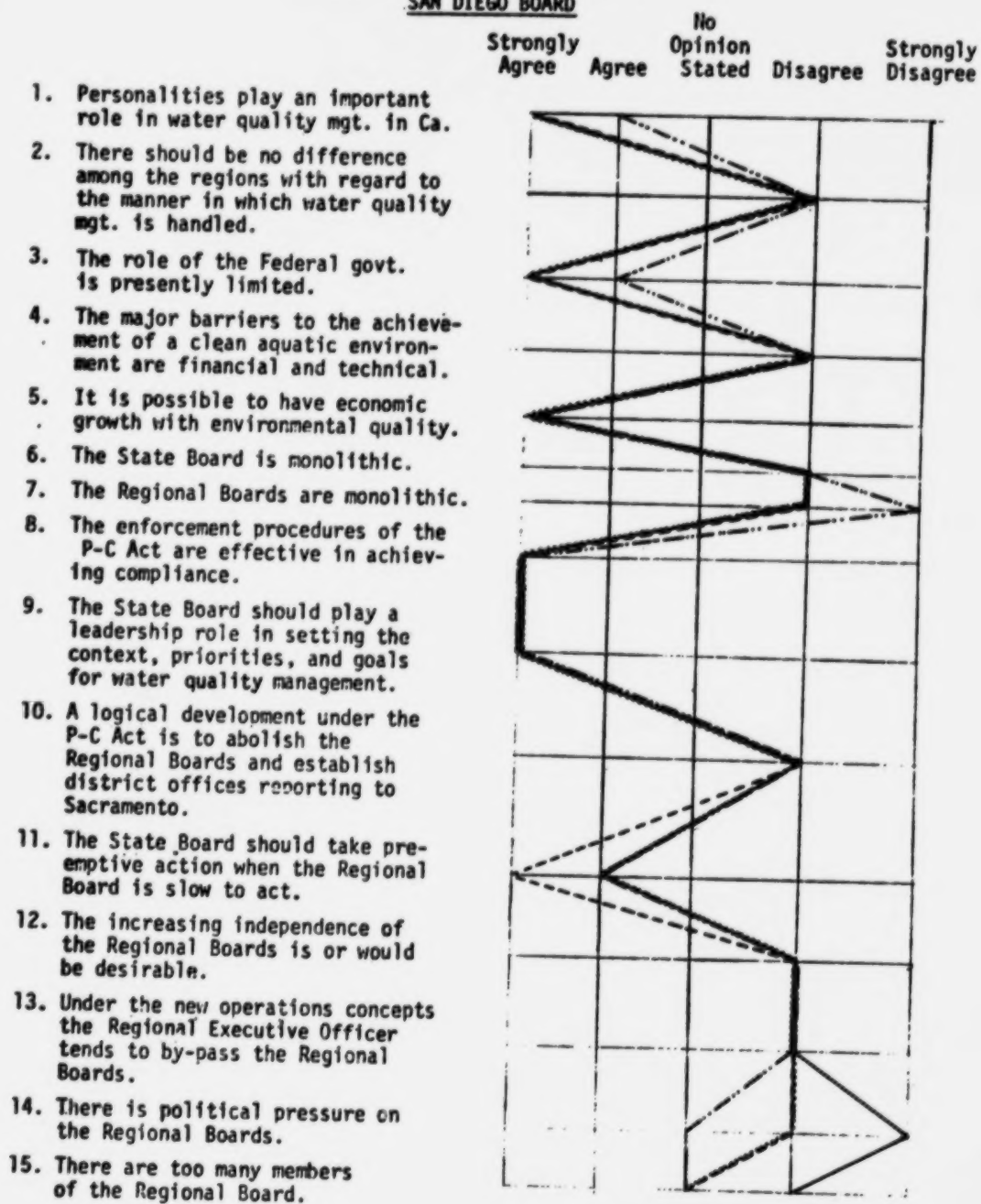


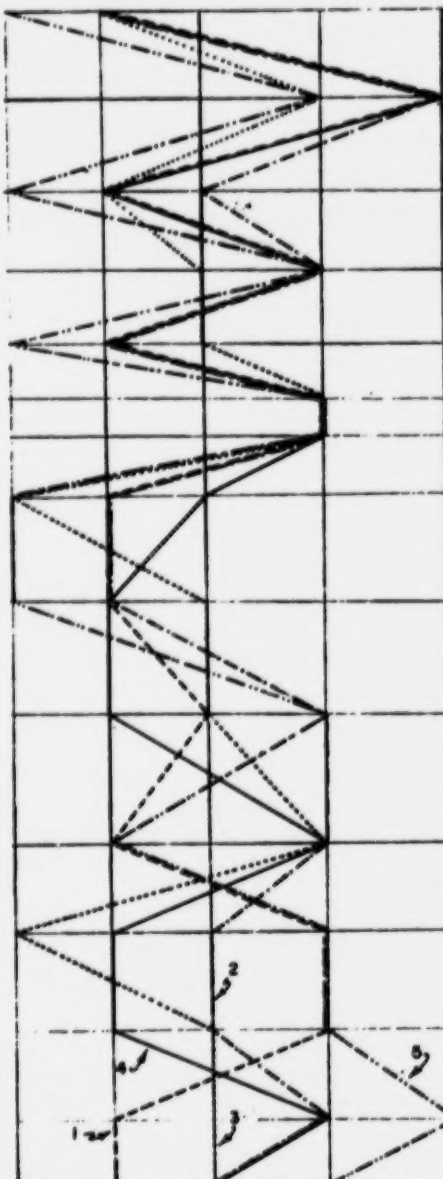
FIGURE III-9

ATTITUDE PROFILES - SERIES IV

EXECUTIVE OFFICERS

Strongly Agree Agree No Opinion Stated Disagree Strongly Disagree

1. Personalities play an important role in water quality mgt. in Ca.
2. There should be no difference among the regions with regard to the manner in which water quality mgt. is handled.
3. The role of the Federal govt. is presently limited.
4. The major barriers to the achievement of a clean aquatic environment are financial and technical.
5. It is possible to have economic growth with environmental quality.
6. The State Board is monolithic.
7. The Regional Boards are monolithic.
8. The enforcement procedures of the P-C Act are effective in achieving compliance.
9. The State Board should play a leadership role in setting the context, priorities, and goals for water quality management.
10. A logical development under the P-C Act is to abolish the Regional Boards and establish district offices reporting to Sacramento.
11. The State Board should take preemptive action when the Regional Board is slow to act.
12. The increasing independence of the Regional Boards is or would be desirable.
13. Under the new operations concepts the Regional Executive Officer tends to by-pass the Regional Boards.
14. There is political pressure on the Regional Boards.
15. There are too many members of the Regional Board.



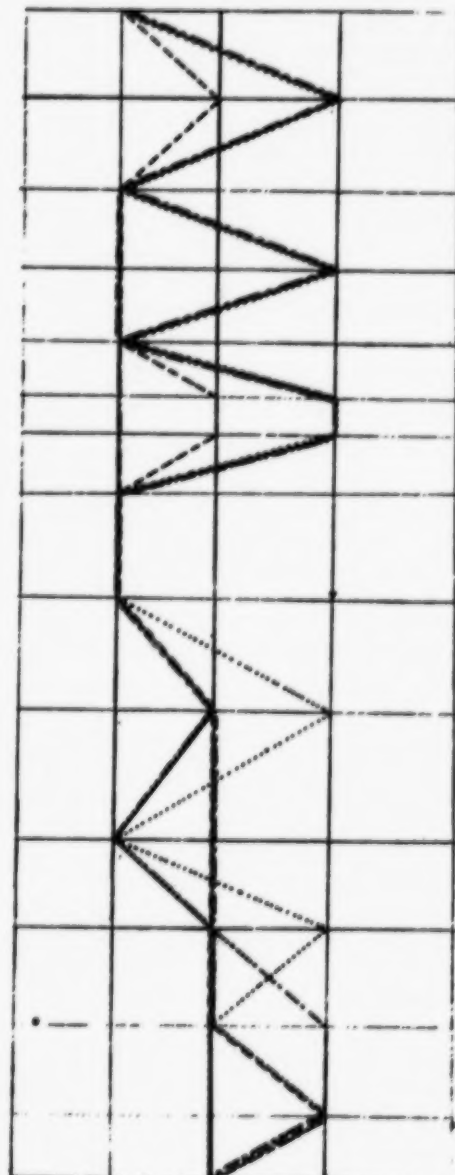
Key: (1) Central Valley; (2) Lahontan; (3) North Coast; (4) Los Angeles; (5) San Diego

ATTITUDE PROFILES - SERIES V

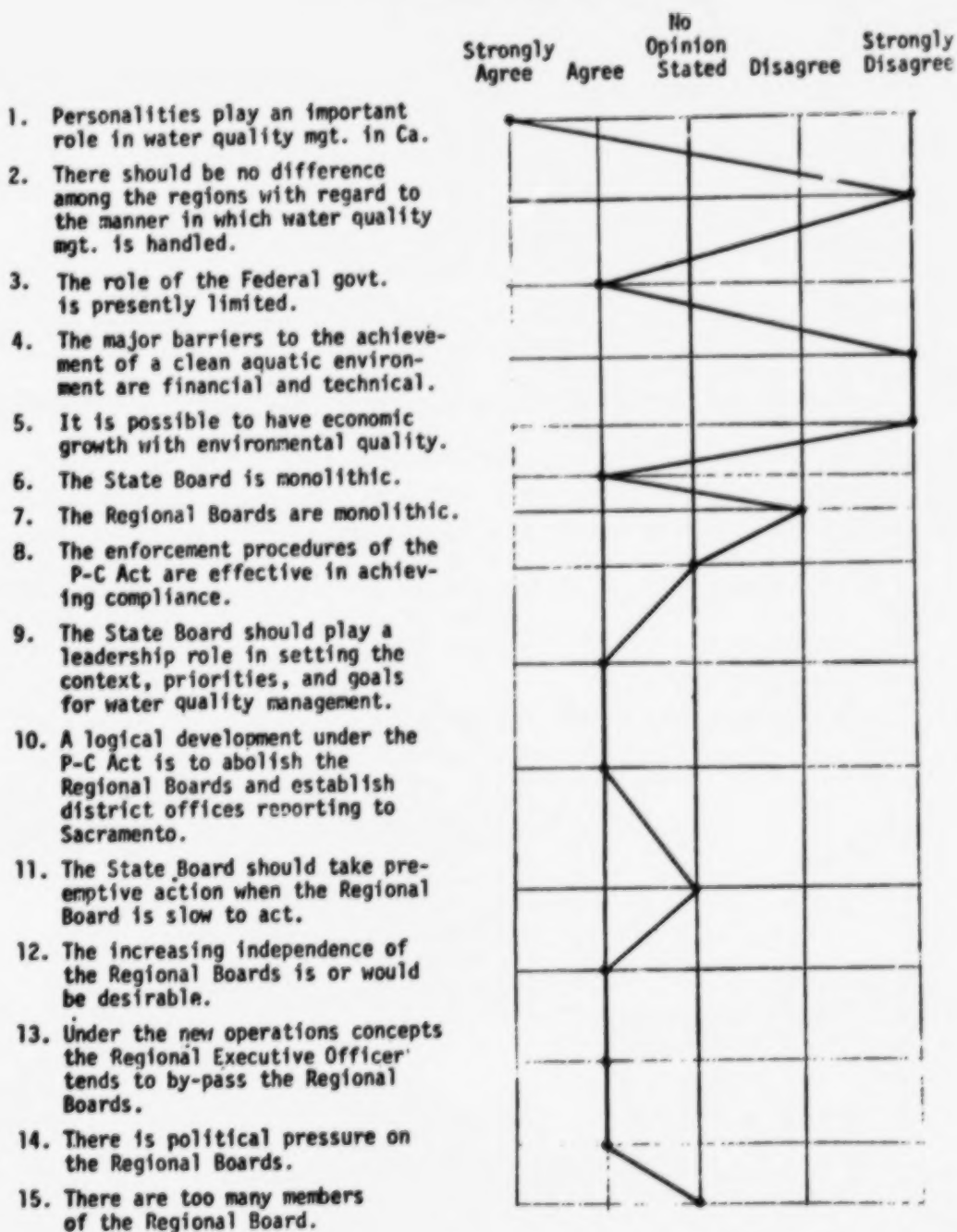
FEDERAL AGENCIES

Strongly Agree Agree No Opinion Stated Disagree Strongly Disagree

1. Personalities play an important role in water quality mgt. in Ca.
2. There should be no difference among the regions with regard to the manner in which water quality mgt. is handled.
3. The role of the Federal govt. is presently limited.
4. The major barriers to the achievement of a clean aquatic environment are financial and technical.
5. It is possible to have economic growth with environmental quality.
6. The State Board is monolithic.
7. The Regional Boards are monolithic.
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14. There is political pressure on the Regional Boards.
15. There are too many members of the Regional Board.



ATTITUDE PROFILE - RESEARCHERS



Although it is generally believed that there should be differences between regions with regard to the administration of water quality, the profiles of the different Regional Boards are essentially similar for statements 1 through 7, which relate basically to the philosophy of water quality control. The major diversity among the different interest groups appears in the statements relating to the administrative and operations concepts of the Board. Thus, this indicates that the givens held by most members of the system are uniform with regard to the "larger" picture, and that it is the day-to-day operations of the Boards which people tend to question.

Series II

The profiles of Series II present individual responses on the parts of members and staff of the State Water Resources Control Board. The members and staff hold principally the same opinions, although there is more diversity in the profiles of the staff. Strong opinions are common. The profiles appear to follow the line of strong centralized control, at the same time maintaining that the Regional Board do exist as semi-autonomous groups, but conversely, the Regional Executive Officer is seen as responsive to the State Board. Thus, it appears that the profile positions with respect to the independence of the Regional Boards are formal statements required by the political climate. This is further corroborated by the general opinion that there are too many members on the Regional Boards. Again, while it is commonly maintained that the State Board is not monolithic, the profiles of the members are quite similar.

Series III

The profiles of Series III represent the individual profiles for the members and executive officer of the San Diego Regional Board. The profiles are both very strong in terms of opinion, and also extremely cohesive, significantly more so than for any other group. The executive officer appears to be fully in tune with the Board members. As has been mentioned, the San Diego Board is considered by the State Board to be the most "successful" of the Regional Boards, and is often held up as a model for other Boards to emulate. The strong sense of agreement with the possibility of economic growth and environmental quality is probably directly related to the success that the San Diego Board has had in precisely that area.

Series IV

Series IV profiles are those for the executive officers of five Regional Boards. Again, the general "philosophical" basis of statements 1 through 8 are similar, but there is significant difference with regard to the operational and administrative aspects of the Board structure,

which serves to reflect the distinct operating styles that the Regional Boards have enjoyed during the past.

Series V

Federal agencies do not participate significantly in the decision-making, except on specific local problems (viz., San Diego). The profiles of Series V, Federal agencies (excepting FWQA), show that the majority of Federal agencies hold normative views, with no strong opinions. With regard to the administrative and operative features of the Board system, there is a preponderance of "no opinion stated" responses.

BEHAVIOR OF THE DECISION-MAKING SYSTEM

Decision-Making Under the Dickey Act

Under the Dickey Act, regionalism constituted the principle framework for water quality decision-making. California was divided into nine regions on the basis of hydrologic and socio-economic factors. Each of these regions was administered by a Regional Water Quality Control Board. The Boards, comprised of seven gubernatorially-appointed members to the Board *per se*, an executive officer, and associated technical staff, had the following basic functions.

- Enunciation, in each region, of the beneficial water uses which the Board intended to protect.
- Definition of water quality objectives (i.e., technical standards) to protect such beneficial uses.
- Case-by-case prescription of waste discharge requirements.
- Monitoring of compliance on the part of the dischargers.

Only limited explicit administrative enforcement procedures were available to the Regional Boards; the typical approach to achieving compliance was that of encouraging cooperation on the part of the discharger.

Two principal characteristics of the decision-making process evolved under the preceding structure:

- The executive officer of the Regional Board became the key individual in the decision-making process; inasmuch as the appointed Board members were not involved full time and were often not highly technically qualified in the specific areas of concern, the Regional Boards relied principally on the technical judgment of the executive officer, and functioned to approve, delay,

or revise in some measure the recommendations of the executive officer and his staff.

- Lacking explicit enforcement procedures, the principal mode of operation of the Boards was one of responsiveness to local vested interests within the region. The Regional concept made the Board members and executive officer accessible to the local vested interests, and, in fact, dictated that the Board act as an integrator of the various regional interests. In regions where a community of interest relating to high water quality could be developed (e.g., the San Diego region), compliance could be achieved voluntarily; otherwise, long delays and token response were common (e.g., the San Francisco region).

The Porter-Cologne Act/Environmental Awareness

During 1968-69, a study panel composed of key individuals in the water quality management structure in California undertook a comprehensive review of the legislation and practices under the Dickey Act, with a view towards designing new and more effective legislation. The findings of this panel, in large measure, were incorporated into the drafting and final form of the Porter-Cologne Water Quality Control Act which became effective on 1 January 1970. Passage of this act was facilitated by a "rising tide of environmental awareness", stimulated in particular in California by the high-visibility Santa Barbara Oil Spill incident of 1969. During 1969-70 also, environmental questions first became significant as major political issues, and an attendant high priority was placed on an "activist" approach on the part of government.

The major changes to the Dickey Act legislation as provided by the Porter-Cologne Act are as follows:

- The State Water Resources Control Board (State Board) is specifically designated as the source of policy for water quality management; the act provides a number of features tending to centralize control of water quality management in the State Board, diminishing the previous autonomy of the Regional Boards.
- The definition of "pollution" no longer contains the concept of "adverse" effects on water quality. The discretionary powers of the Regional and State Boards are relied upon to determine the "unreasonable" impairment of beneficial uses.
- Explicit administrative enforcement procedures are granted to the Regional Boards, including the imposition of a maximum of \$6,000/day in fines for violation of discharge requirements under a cease-and-desist order, and prohibition of new connections to sewerage systems when a cease-and-desist order is in effect.

- Esthetic enjoyment is included as a beneficial use of the waters of the State, while waste assimilation as a beneficial use is no longer explicitly mentioned, as it was under the Dickey Act.
- Two new members are added to each Regional Board, bringing the total up to nine; Board members, although having backgrounds in diverse fields, are to represent the interests of all the people of the State. Under the Dickey Act, members were representative of specific interest groups.
- The State Board has the power to review upon its own initiative, any action or inaction of the Regional Boards.

The Porter-Cologne Act is not so much a prescription for action as a vehicle, providing a structure and channel by which an activist approach to water quality management can be undertaken by individuals within the structure. Such has, in fact, proven to be the case; a small number of individuals, principally associated with the State Board and its staff, have used the full range of authority granted to the State Board under the act, to place a definite direction and philosophy on the water quality management decision-making process in California. This direction and philosophy, as evidenced in the transient phase, is described subsequently.

Characteristics of the Transient Phase

In dealing with social systems, it is seldom possible to define clear transition times between one mode of behavior and another; thus, for the case of water quality management in California, the transient phase can be dated from 1 January 1970, when the Porter-Cologne Act took effect, but the groundwork necessary to reach that point can be traced to earlier events. The principle initial manifestation of a change in guiding direction for water quality management decision-making in California was the initiation, in early 1968, of a comprehensive review of the water quality legislation and administration practices, in the form of a study project, authorized by the State Board. (Alternatively, the re-organization of the State administration of water resources, with the establishment of the State Water Resources Control Board itself, in 1967, may be seen by some as the formal initiation of the transient phase). The recommendations of the study project, presented in final form to the California Legislature in March 1969, were principally incorporated into the Porter-Cologne Act.

As noted above, the Porter-Cologne Act provided a vehicle for the exercise of a new "activism" in water quality control. For the first few months of 1970, however, there was no noticeable impact upon the actions of the various Regional Boards. The first obvious overt exercise of the new prerogatives took place in March of 1970; the State Water Resources Control Board pre-empted the authority of the San Francisco Bay

Regional Board in a number of cases, and issued cease-and-desist orders under the new legislation. In the case of San Francisco, the administrative enforcement procedure preventing new sewerage connections was invoked. This initial "pulse" to the system on the part of the State Board resulted in a dynamic response in a number of sectors; on the part of the Regional Boards, there was a good deal of confusion and some hostility towards the State Board as a result of the State Board's pre-emptive action. The San Francisco case rapidly elevated into a confrontation between the Mayor and the State Board, with large attention from the media. It appeared possible that a court test of the Porter-Cologne Act might take place, but a variety of factors, including the State-wide political climate at the time, led to a negotiated settlement of the problem.

With regards to the internal character of the decision-making process, the pre-emptive action of the State Board led to an increase of tension between the State and the Regional Boards. This tension, developing principally out of the Regional Board's ignorance of the State Board's actions and intentions, was further enhanced by the long delay in the appointment of the two new members to each Regional Board, as provided in the Porter-Cologne Act. The appointment of these members, principally from the technical/environmental sciences and environmental activist interest groups, together with a more conciliatory, "training" tone adopted by the State Board, led to a reduction in tension and an apparent affirmation of the State Board's position by the end of 1970.

During much of 1970, the position of the State Board, in explaining its pre-emptive actions, was that their purpose was to demonstrate the "activist" approach, and the use of the new Porter-Cologne powers, to the Regional Boards, in the hopes that the Regional Boards themselves would adopt the "activist" stance. By November of 1970, the State Board was still in the position of encouraging the Regional Boards to take stronger affirmative actions. Throughout this period, the San Diego Regional Board has held up as a "model" for the other Regional Boards to emulate; the San Diego Regional Board has been quite successful in achieving a community of interest, centered around recreation and tourism, with regards to maintenance of high water quality within a relatively small region.

Towards the end of 1970, the State Board issued, under its legislative authority, the first comprehensive set of administrative guidelines for the functioning of the Regional Boards. These guidelines clearly indicate that the Regional Executive Officer is the primary individual for communicating with the public and the State Board; thus, specific importance is attached to this position. These guidelines can be interpreted as a further extension of authority of the State Board over the mode of operation of the Regional Boards.

During most of the transient phase to the date of this report, there was little apparent activity in the Federal arena in terms of inter-agency

decision-making, with the exception of certain policies of the Corps of Engineers. These policies, in essence, require State Board certification of projects prior to the Corps' issuance of offshore construction permits, thus lending additional weight to the State Board authority. The absence of significant Federal interaction is ascribed to the anticipation of a long period for startup of the Environmental Protection Agency - most Federal agencies appeared to follow a "holding action" until the structure of the new agency was finalized. Although a number of controversial arenas have direct Federal concern (Lake Tahoe, Pyramid Lake, off-shore drilling), Federal interactions in decision-making have maintained a "low profile" to date.

In summary, then, the transient phase to date has been a process of gradual centralization of control of water quality management decision-making in the hands of the State Water Resources Control Board. In the process, certain problems have been manifest with the Regional Boards and the dischargers, but to date, no unmanageable opposition to the policies of the State Board has developed, either administratively, legally, or politically.

CHAPTER IV

CONCEPTUAL, DESCRIPTIVE, AND THEORETICAL MODELS

INTRODUCTION

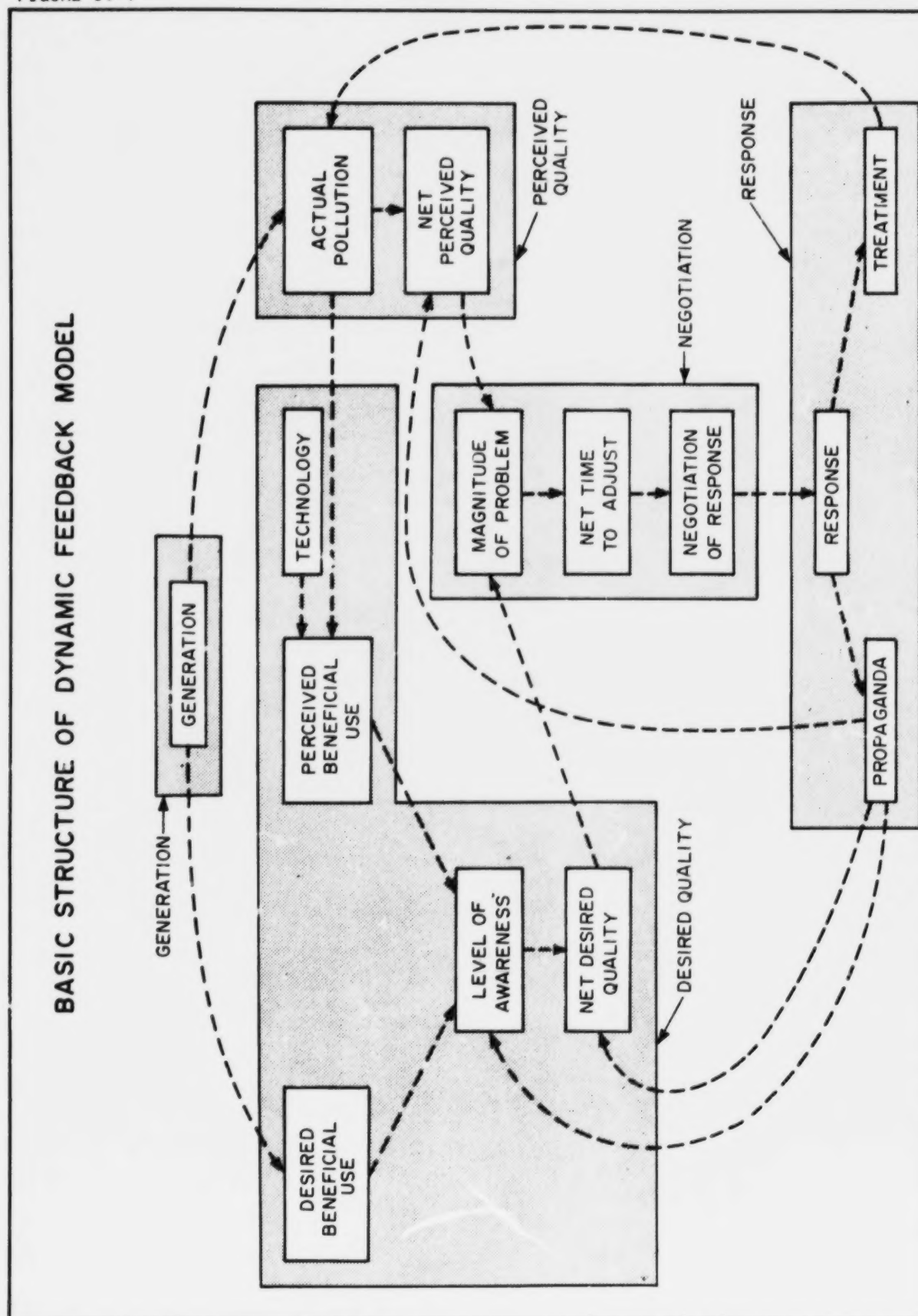
Three basic models were developed and used during the course of the study. The conceptual model represents the over-all framework within which the current state of water quality management decision-making in California was and is viewed by the researchers. This over-all framework has been translated into a programmed model, termed the descriptive model, for computer simulation. The descriptive model was initially envisioned as a broad-scale model of the decision-making process, incorporating such behavioral factors as hostility, dominance, cooperation, and individual personality measures. It soon became apparent that the detailed inter-personal, short-time scale dynamics of the decision-making process could not be incorporated in the decision-making model under the scope, budget, time, and political constraints of the present study. Accordingly, the detailed conflict behavior was separated from the descriptive model. This latter model is theoretical in that it does not draw upon a specific real-life situation for data and structure; rather the model represents a scenario, paradigm, or generic behavioral situation for two-party interaction. The descriptive model remains the expression of the macro-scale, long-term behavior of the decision-making system and structure.

CONCEPTUAL MODEL

The conceptual framework for the water quality management decision-making process remains unchanged, in essence, from that developed during the first-year study. The decision-making process is seen as a dynamic, feedback oriented process involving the conflict/cooperation of various interest groups. The Regional and State Boards, and the Regional Executive Officer, participate in the process as integrators of opinion of the various groups, as well as holding their own intrinsic opinions. The balance of intrinsic and integrated opinions determines the "decisions" of the Board. The basic components of the model are illustrated schematically in Figure IV-1. The structure is divided into five functional areas:

- (1) Generation.
- (2) Desired quality.
- (3) Perceived quality.
- (4) Negotiation.
- (5) Response.

FIGURE IV-1



Within each functional area, a number of components are indicated. In the three components of net desired quality, net perceived quality, and net time to adjust, the Board exercises functional decisions. The over-all structure is described below.

The generating levels (population, industry, and agriculture) produce both water-borne wastes and a desire for water of high quality for beneficial use. The water-borne wastes influence the level of actual pollution, and the need for clean water influences the desired beneficial use level. Since the generating levels are taken as increasing with time, a continual strain is placed on the environment, which must be resolved by the resource management process.

The level of awareness of a water quality problem, which is the motivating force for corrective action, is a consequence of and is stimulated by the difference between desired and perceived beneficial use of the water resource. The perception of the beneficial use being obtained from the water resource is a function of the actual pollution level and the existing technology at a given time. Increases in technology act to illuminate the existence and effects of pollution, and consequently, increased levels of technology result in decreased perceived beneficial uses for a constant level of actual pollution. For each individual, group, agency, or for the population as a whole, the comparison between desired and perceived beneficial use stimulates awareness. This awareness results in the establishment of opinions on desired levels of quality (water quality standards). This desired quality standard is compared with the perceived quality of existing waters to determine the magnitude of the existing water quality problem. Perceived quality is a function of the actual pollution level and the point of view; some sectors tend to maximize perceived quality.

Based on the magnitude of the problem, a time to adjust the perceived to the desired quality is set (a time schedule for compliance with standards). At this point, there is usually general agreement as to problem level, and negotiation centers on the rate of adjustment. Thus, the negotiation component becomes operative in the process. Negotiation will result in a response to the problem, which may take the form of either treatment (including source reduction) or propaganda or both; treatment feeds back to the actual pollution level, and propaganda influences the decision-making process. The process is dynamic because of growth of the generating levels and technology and through the feedbacks which affect the decision-making process and pollution level.

The fundamental question confronting the researchers in the development of the conceptual model was whether or not the basic structure of the decision-making process had been changed by the developments under the Porter-Cologne Act. Two concepts of the Porter-Cologne Act seemed potentially capable of necessitating a revision in the model:

- Control of the generating levels - through the provision of the Porter-Cologne Act relating to prohibition of new sewerage connections, which amounts essentially to a building ban, because building permits are denied under this situation.
- Enforcement capabilities under the Porter-Cologne Act - the possibility of application of up to \$6,000/day fines, together with the application of the building ban noted above, could potentially have removed the negotiation character from the response sector of the first-year structure.

Examination of the implications, and apparent practice relating to the two items above, indicated that, at least at present, direct control of generating levels as a basic alternative approach to achieving high water quality does not exist (occasional cases where developments have been forestalled or prohibited due to actions of the State Board have taken place in 1970, but the practice is not general). In regards to the matter of enforcement, it seems clear that the "big stick" of the fine and prohibition of new sewer connections has been, and will continue to be, used principally as a negotiation tool on the part of the Regional and State Boards. Thus, the achievement of compliance is still essentially a negotiation process. Accordingly, the fundamental structure for water quality management decision-making developed in the first-year study is still valid, at least at the present point in the transient phase. The significant change in the decision-making process, of course, is the primacy of the State Board, rather than the Regional Board, and the dichotomous position of the Regional Executive Officer, responsible to the Regional Board formally, and to the State Board informally.

THE DESCRIPTIVE MODEL

As noted previously, the structure and framework for the descriptive model of water quality management decision-making is based on the model developed during the first-year study. This framework is that of the conceptual model.

The over-all model structure of the first year made use of the following mechanisms:

- The Regional Board and executive officer as integrators of points of view of various interest groups, through an averaging process.
- Mutual adjustment of points of view between the executive officer and the seven-member Regional Board, over time.

Within this framework, there was a clear division between those individuals/groups that participated in the decision-making process as primary decision-makers, and those that participated as interest groups.

The distinction, in terms of the model was that the primary decision-makers formulated their opinions and decisions based on information received from the various interest groups, while the interest groups formulated their opinions directly from sources in the socio-economic-physical system. Thus, the interest groups were the technical staff of the Regional Board, a generic "conservationist" point of view, and a generic "discharger", while the seven-member Regional Board, presumed to act monolithically, and the executive officer, were considered primary decision-makers. In the model formulation, the State Board was considered to act as an interest group.

Modifications to the Descriptive Model

The two factors of main significance in the transient phase of the decision-making process are the entry of the State Board, and the increased enforcement powers. Given that the over-all framework of the first-year study was accepted as a starting point for the descriptive model, the question then became that of determining the necessary changes to incorporate the preceding two factors.

The primacy of the State Board is represented in the conceptual and descriptive models through use of the mechanism of "pre-emption". Through the use of this mechanism, the State Board can "re-set" the opinions (quantified values) of the Regional Board and executive officer. Pre-emption takes place when the difference of opinion between the State Board and either group exceeds a variable tolerance limit. Pre-emption can also take place with respect to the discharger's level of commitment to problem resolution, and as such, models the increased enforcement powers. That such pre-emption of the discharger occurs, and is not final and absolute, is demonstrated in the case history of the City of San Francisco; the State Board pre-empted the city's level of commitment, which resulted in a negotiation process, leading to a compromise solution. Thus, the pre-emption is viewed as a portion of the negotiation functional area, rather than as an absolute enforcement power. (It should be noted that the "pre-emptive power" of the State Board has not yet received a serious challenge by a discharger other than San Francisco). The pre-emption concept is explored in greater detail in the theoretical model.

Descriptive Model Structure

The conceptual model described above was programmed and coded in DYNAMO II (Reference IV-1) for the IBM 360/40 computer. The detailed program listing is presented in Appendix A. The over-all program structure is similar to that developed in the first-year study, inasmuch as the conceptual model remains essentially unchanged. The detailed description of this structure is described in the study report (Reference IV-2) of the first year study. The two structural features of the model

which have been significantly modified are the mutual adjustment process taking place in each functional decision area, and the response sector, and are described below.

Mutual Adjustment Mechanism

Three components participate in the Board decision-making process - the State Board, the Regional Board, and the Regional Executive Officer. Each decision is the product of an averaging/adjustment process, in which the opinions of the various interest groups are incorporated at different relative weights. For the current version of the descriptive model, three interest groups are identified: the technical staff of the Regional Board; a "generic" discharger; and a "generic" conservation group. Each of these groups formulates its opinion (a quantified value of desired level of quality, perceived level of quality, or desired time to adjust), directly from the respective system level (level of awareness, level of pollution, and problem magnitude). Each of the primary decision-makers is considered to hold simultaneously two opinions in relation to the given quantity: the aggregate opinion; and the intrinsic, or net opinion. The aggregate opinion is a weighted average of the opinions of the respective interest groups and the decision-maker's own intrinsic opinion, for example:

$$\begin{aligned} \text{aggregate opinion (EO)} &= W1 (\text{discharger opinion}) + W2 (\text{conser-} \\ &\quad \text{vationist opinion}) + W3 (\text{staff opinion}) \\ &\quad + W4 (\text{intrinsic opinion EO}) \end{aligned}$$

where: W1, W2, W3, and W4 are averaging weights, and sum to one. The weights are determined by propaganda directed at the particular target by the interest group for the case of the external opinions; the self-weight assigned to one's own intrinsic opinion is based on the relative disagreement with the other decision-makers - the less the disagreement, the higher the self-weight.

This aggregate opinion is developed for each of the three decision-makers; for State and Regional Boards, the technical staff interest group opinion is not included, inasmuch as this input is presumed to act solely through the executive officer. The aggregate opinion represents the continuing re-integration process which each individual goes through, assessing and re-weighting his own opinion in regard to that of others.

The net opinion represents the responses to the intra-Board adjustment process between the Regional Board, State Board, and executive officer, and is the arena in which negotiation, education and pre-emption of opinion takes place. Each party assesses the difference between its own opinion and that of the other two parties, and adjusts its previous net opinion

by a weighted average of the difference with respect to the other parties, as follows:

$$\begin{aligned} \text{new intrinsic opinion } EO &= \text{old intrinsic opinion } EO + C1 \\ &\quad (EO \text{ aggregate opinion} - \text{RB aggregate opinion as perceived} \\ &\quad \text{by } EO) + C2 (EO \text{ aggregate opinion} - \text{SB aggregate opinion as} \\ &\quad \text{perceived by } EO) \end{aligned}$$

where: C1 and C2 are weights which vary with time, and represent the relative responsiveness of each party to the other two parties. Thus, the intrinsic opinion adjustment process is a continual revision of the previous intrinsic opinion, based upon the perception of the other parties. The manner in which the weights C1 and C2 vary over time is an external behavioral parameter of the model, which can serve to express such behavior as the gradual accommodation of the State Board by the Regional Board over time, or the shift in emphasis towards the State Board and away from the Regional Board on the part of the executive officer.

The pre-emption mechanism takes place when the difference in perception, as seen by the State Board, exceeds a trigger value, which is taken as a variable percentage of the State Board's aggregate opinion. When this trigger level is exceeded, the intrinsic opinion for the Regional Executive Officer is re-set as follows:

$$\text{new intrinsic opinion} = \text{SB aggregate opinion}$$

The mutual adjustment mechanism provides for the three basic modes of dominant party - subject party interaction; education, negotiation, and pre-emption. The education and negotiation modes are controlled by the variation of weights C1 and C2 over time, while the pre-emption mechanism is controlled by the external parameters defining the trigger mechanism.

Response Sector Mechanisms

Within the response sector, the desired rates of problem adjustment as seen by the discharger and the three decision-making entities are negotiated, leading eventually to some level of response on the part of the discharger in the form of an increase in dollar commitment to problem resolutions. The negotiation process used in the first-year model represented the situation in which no enforcement powers existed, and hence it was not possible to force the discharger to respond at a rate higher than that which he desired. Under this situation, the discharger would assess the difference in position between his own opinion and that of the Regional Board; if this difference in opinion fell within certain tolerance limits, the discharger would respond at his own desired rate. If, however, the difference of opinion was excessive on the side of "too high" Regional Board demands, the discharger would not respond at all - the directives of the Board were ignored. Under this system, the optimal

behavior for the Regional Board was that of encouraging responsiveness on the part of the discharger, i.e., educating the discharger to broaden his tolerance limits.

With the enactment of the Porter-Cologne Act providing some measure of coercion over the discharger, an additional feature has been added to the above negotiation process. This is the idea of "pre-emption" of the discharger's level of commitment, mentioned previously. Under this model, when the difference in desired rates of adjustment between the State Board and the discharger becomes too great, the State Board can pre-empt the discharger, setting a new level of commitment instantaneously. (The grant application and funding control powers that the State Board holds lend credence to this mechanism). Thus, two separate mechanisms are available for adjustment of the discharger's commitment; behavioral parameters of the model (responsiveness of discharger, tolerance limits of State Board), determine which mechanism is selected at a given time.

The level of commitment, in terms of dollars, is the driving force for two forms of response: propaganda and treatment. Propaganda is information generated by the discharger and inserted into the decision-making process in an attempt to readjust opinions. Treatment is modeled as a certain percentage removal of the influent pollution loading on the environment; waste assimilation is also assumed to act on the reservoir of pollutional loading. The percentage pollution removal by treatment is a function of the dollar level of commitment, and shows diminishing returns to scale, since the marginal removal per treatment dollar diminishes as the percentage removal increases (moving from 70 to 71 percent removal costs less than moving from 95 to 96 percent removal, under most current treatment technology).

MODEL TESTS

The model was tested for the generic situation of an industrial waste discharger and a conservation group as interest groups, with the State Board, Regional Board, and executive officer as primary decision-makers. The relationship between the three primary decision-makers was taken as that of gradual assumption of control by the State Board over time; i.e., the executive officer initially is more responsive, and more heavily weights the Regional Board, but over time, responds more to the State Board. Similarly, the Regional Board initially maintains an independent position, but over time becomes subordinate to the State Board. Parameters were set to yield a high level of awareness throughout the model simulation period.

Following debugging and model checkout, model runs were made to investigate the system behavior under different conditions of discharger responsiveness, State Board pre-emption, and economic/pollution/beneficial use growth rates. Inasmuch as the formal objective of the water

quality management process is to reduce pollutional loading of the water environment, the actual pollution level over time was the principal parameter measure of system behavior. The model runs were carried out for a 400-month simulation, in order to investigate the long-term behavior of the system. Pollution and desired beneficial use at a given time is obtained by multiplying the level of growth at that time by the respective factor, which may itself be constant or increasing with time. Runs were organized as follows:

<u>Run</u>	<u>Characteristics</u>
Base	Linear growth, constant factors, non-responsive discharger, no State Board pre-emption of commitment
1	Same as above, more responsive discharger
2	Same as above, more responsive discharger
3	Non-responsive discharger, State Board pre-emption
4	Occasional pre-emption, semi-responsive discharger

5	Same as Run 4, linear growth, increasing factors
6	Same as Run 4, zero growth rate, constant factors
7	Same as Run 4, exponential growth, constant factors
8	Same as Run 4, exponential growth, increasing factors for pollution, desired beneficial use

9	Same as Run 4, obsolescence rate of treatment technology reduced by half

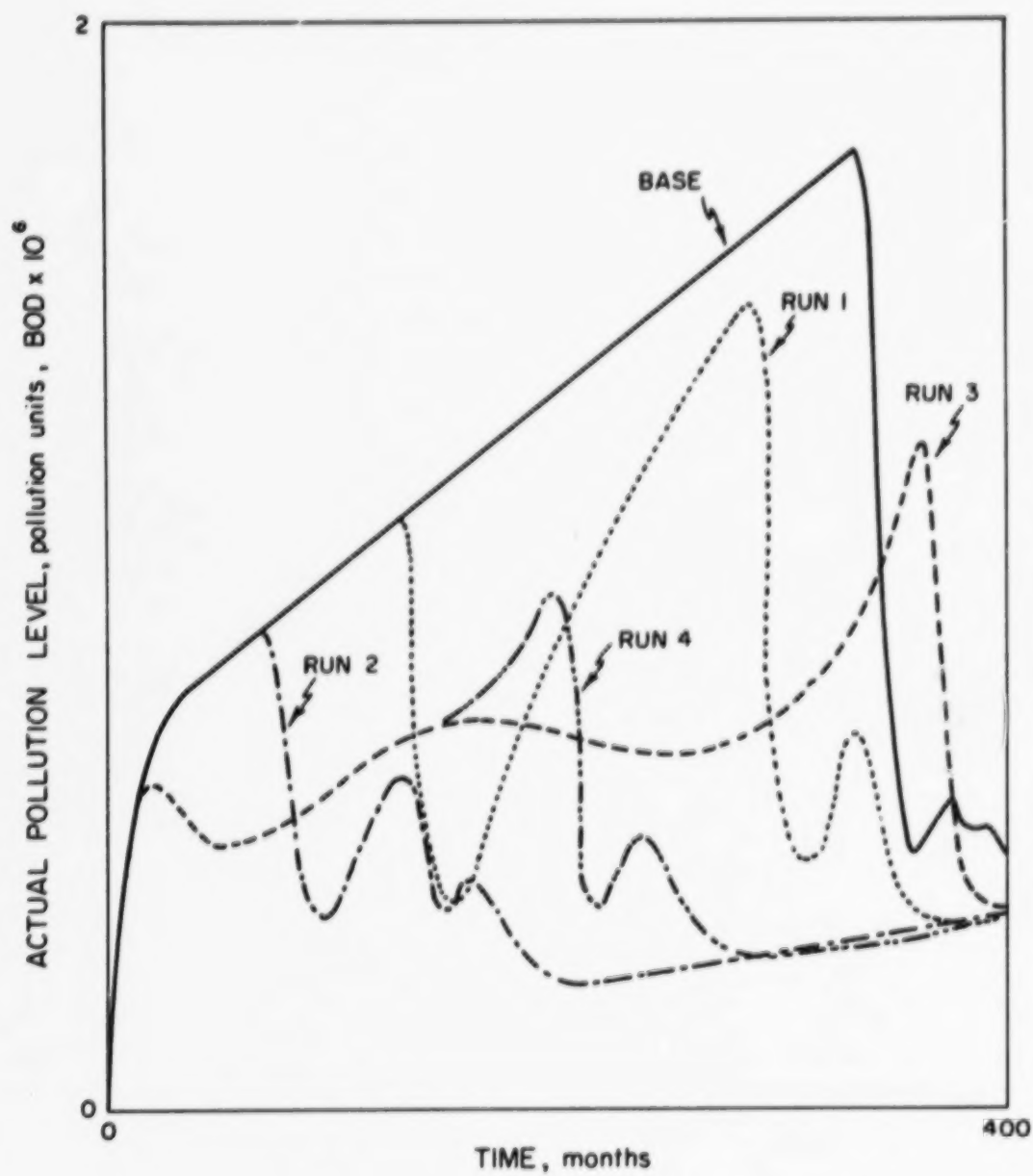
The first series of runs (Base - 4) constitute an investigation of modes of control strategy, for a society growing at a constant rate, with constant pollution and beneficial use demand per unit of growth. The second series of runs (5-8) are an investigation of the effect of growth, demand, and pollution rates on system response for the control strategy of Run 4. Run 9 is an investigation of the effect of treatment technology on long-term system response.

RESULTS

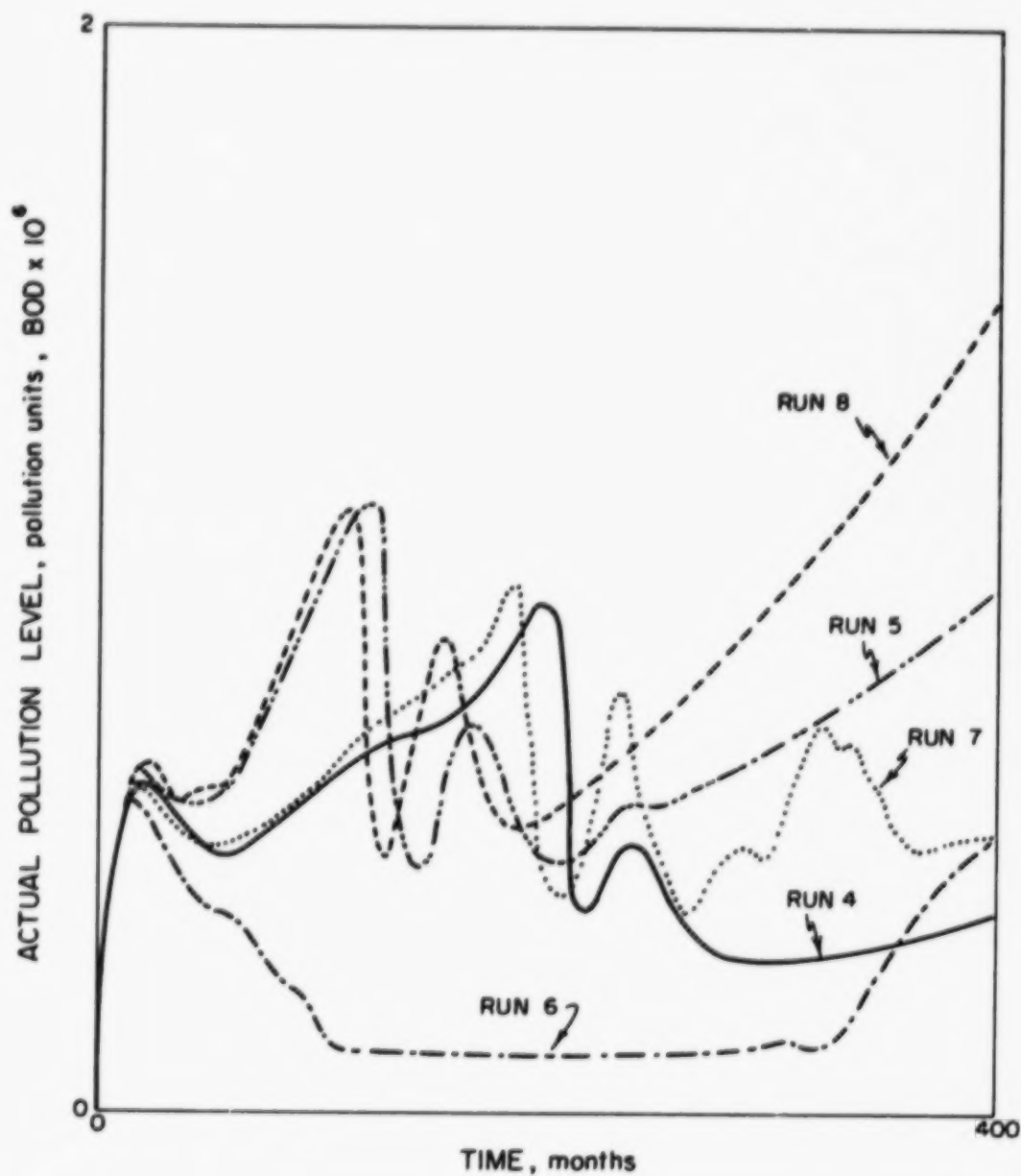
The results of the computer simulations, expressed as plots of actual pollution level over time, are shown in Figures IV-2 through IV-4. Referring to Figure IV-2, for the conditions of the base run, pollution rises rapidly as the discharger maintains his unresponsive pose. Eventually, however, the discharger responds, due to the extremity of the

FIGURE IV-2

MODEL RESULTS - SERIES I



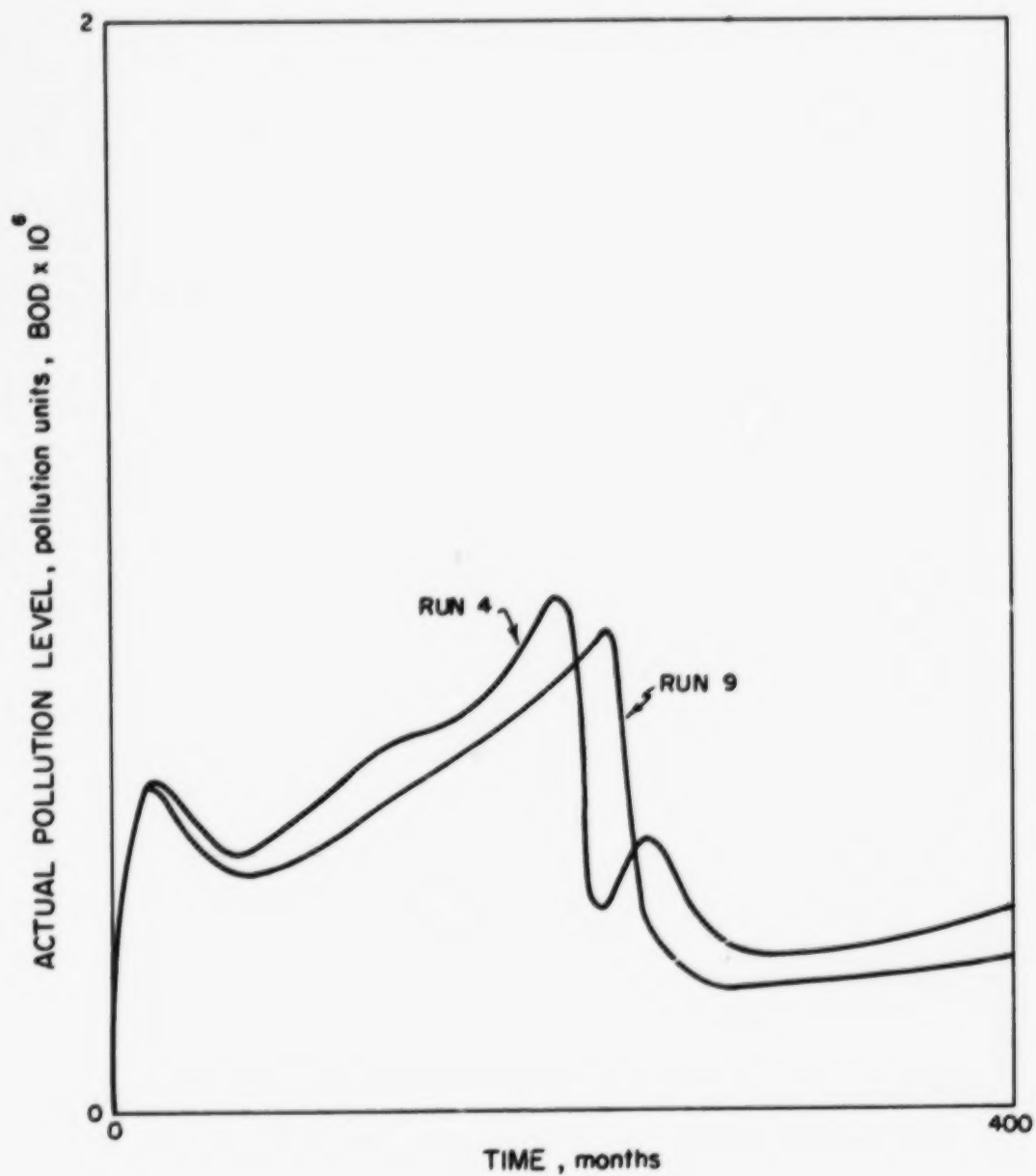
MODEL RESULTS - SERIES II



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FIGURE IV-4

MODEL RESULTS - SERIES III



problem, rapidly reducing the level of pollution. There is essentially no external control - reduction is driven totally off the desires of the discharger who responds when the Board finally falls within his tolerance limits. For Run 1, the discharger has wider tolerance limits, and is willing to respond with commitment under a wider range of disagreement with the Regional Board. A typical cyclic pattern of response-no response appears. For Run 2, the discharger has still wider tolerance limits, and is responding almost continuously. This is effective in terms of initial reduction, but eventually, response is rate-limited by the effectiveness of technology of treatment, and pollution starts to rise again. This rate of rise may be termed the "intrinsic" rate of rise for a given societal growth and technologic capacity, and it can be seen that all the curves of Figure IV-2 approach this intrinsic rate of pollution growth, as commitment and response reach saturation levels.

The foregoing curves represent a situation similar to that of the first-year study, since response is solely dependent upon the attitude of the discharger. For the case of Run 3, the behavioral parameters are such that the State Board is continually pre-empting the discharger, i.e., a continual enforcement activity takes place. Under this situation, with the discharger unresponsive, pollution levels are intermediate between the Base Run and Run 2.

The rapid reduction in pollution at 370 months is brought about when the discharger becomes responsive, due to his own perception of the increased problem level. At this point, pre-emption no longer is taking place. As the resources of the discharger are exhausted, the curve approaches the intrinsic rate of growth. The case of Run 4 is that of a semi-responsive discharger, with occasional pre-emptions by the State Board. In the early stages, pre-emption is continual, and the curve follows that of Run 3. This pre-emption continues until the first peak, at which point the discharger acts on his own, causing the sharp drop in pollution, as in Run 3. The curve rapidly approaches the intrinsic rate of rise.

The results of the second series of runs are shown in Figure IV-3. Run 4, deemed the optimal control strategy under linear growth rates (since it is not likely that the discharger will be as responsive as in Run 2), is repeated as a baseline run for comparison. In the situation of Run 5, the same growth rate is maintained, but the demand for beneficial use and the rate of pollution per unit of growth are increasing with time (i.e., each dollar of economic growth results in increasing marginal pollution and marginal demand for clean water over time). Initial pollution is higher, control is effective, but the intrinsic rate of rise is higher and is exponential. For the case of Run 6, there is no increase in growth, rather, a static situation is examined. Pollution levels drop rapidly, but show a surprising increase in the long

term behavior. This increase can be traced to the effects of the low level of problem magnitude as seen by the discharger. This low level, based on the previous low amounts of pollution, leads to a low desired rate of adjustment, and hence a drop in commitment and treatment, leading to the rise in pollution. Although a longer simulation run for these conditions was not carried out, it is likely that a cyclic effect of increasing and decreasing pollution, with periods of minimal pollution in between, would be characteristic of this zero growth state. The final rise rate of pollution in Run 6 is not related to the intrinsic rate of rise, inasmuch as commitment and treatment are reduced, rather than saturated.

The test of Run 7 involves an exponential growth increase, with constant pollution and demand per unit of growth. The typical cyclic pattern appears, and the intrinsic rate of rise is greater than that of the linear growth case, while less than that for Run 5 (linear growth, increasing demand). In Run 8, both exponential growth and increasing demand and pollution per unit of growth are present, leading to the cyclic pattern and an extremely rapid, and exponentially increasing intrinsic rate of rise.

In Run 9, the effect of one of the factors limiting treatment was investigated. The conditions of Run 9 are identical to those of Run 4, with the exception that the rate of obsolescence of treatment has been reduced by half, leading to a higher saturation value for maximum treatment effectiveness. The results of Run 9 are presented in Figure IV-4, together with those of Run 4, again repeated for comparison. The basic patterns are very similar, but the effect on the intrinsic rate of rise is apparent, with the lower obsolescence rate producing a lower intrinsic rate of rise.

CONCLUSIONS BASED ON THE DESCRIPTIVE MODEL RESULTS

The character of the information obtained from dynamic feedback models is that of a complex, moving pattern of interrelationships practically "organic" in character. Most analysts are, by training, unprepared to cope with such information conceptually, and interpretation of the moving pattern, and conclusions drawn from it, will in some measure be subjective, much as the response to a Bach fugue is. Similarly, however, certain structures, underlying patterns, and inter-plays exist in the information, while some of it is embellishment, or irrelevant. Thus, the function of the analyst is to extract those broad principles from the complex information presented to him. The "safest" conclusions are those based on the broadest, most recurrent underlying patterns. With this in mind, then:

- The basic underlying pattern of the structure is that of an initial cyclic period of control/pollution, followed by a

saturation stage in which the available control measures, resources, and technology have been exhausted, leading to an intrinsic rate of rise in pollution in the long-term.

- This intrinsic rate of rise, under the assumptions of the current model, is apparently a function of treatment technology and economic growth rates (including pollution rates and water demand rates). These factors are all exogenous inputs to the model, and are not regulated internally.
- A control strategy for the short-term is apparently possible inasmuch as the behavioral parameters of Run 4 (occasional pre-emption, increased responsiveness of the discharger) are, in fact, now characteristic of the prototype system. This strategy does resolve the short-term problem, but is ineffective in dealing with the intrinsic rate of rise.
- For the long-term, the basic questions of control revolve around achieving a means of controlling the growth, demand, and pollution rates, as well as a continual up-grading of treatment technology. A factor which has not been included in the model, but is recognized by the researchers, is that in the long term, the character of "pollution" will change, i.e., new constituents of waste will be developed and/or detected, and thought of as pollution problems. Accordingly, if treatment technology is to be upgraded, and considering the long lead time necessary for developing and implementing an effective control technology, some consideration should be given to the nature of, and means of treating those future constituents of waste which will be termed "pollutants". Just as the commitment to development of a technology based on BOD removal has resulted in a severe problem of "catching up" to remove the presently recognized pollutants such as nitrates, phosphates, and heavy metals, it must be expected that the present commitment to achieving the current technology is also ignoring future pollutants, and will again result in a catching up problem.

RECOMMENDATIONS

Based on the above concepts and model results, the following recommendations for the over-all direction of the decision-making process are suggested:

- The difference between the nature of the long-term and short-term management problems should be addressed and illuminated by and within the decision-making process.
- The concept of "intrinsic rate of rise", or alternatively, maximum acceptable rate of degradation of the environment, as a function

of growth and technology, should become a fundamental planning principle for water quality management. Selection of such an intrinsic rate, expressing as it does the trade-offs between and among economic growth, environmental quality, technology, and social preference, should be the fundamental policy statement of a control agency and also for each interest group. (It should be noted that a given of the researchers is that the natural rate of rise, which is always positive, is not reversible by man's activities, and, in fact, represents the minimum rate of degradation achievable). The use of such a concept would introduce a measure of "ecological reality" into the current policy practices.

- Basic research into the nature of the potential future degradation causes, and the control technology necessary to treat these problems *a priori* rather than *a posteriori* should be undertaken as a significant priority for the long-term problem set.
- For the short-term control process, it is the combination of pre-emption and education of the discharger which appears to be the "optimal" presently achievable control strategy, and should be implemented. Implicit in this strategy is the existence of some measure of "enforcement" capability on the part of the control agency - "enforcement" in the sense of an ability to achieve compliance, whether through negotiation, abatement procedures, criminal and/or civil penalties, etc.

THE THEORETICAL MODEL

The theoretical model was developed to examine the process of conflict resolution between two parties when one party occupies a dominant position and the other party a subject position, in order to:

- Gain insights into the interactions present in the California water quality management decision-making process.
- Quantitatively characterize the structure of a basic behavioral process.

The model is theoretical in the sense that it does not purport to simulate a specific real-world case, and parameter values were set arbitrarily by the investigators, rather than through empirical examination of a specific system. The logical extension of this modeling effort, of course, is to apply the theoretical model to a real-world situation, using behavioral data-gathering techniques to obtain the needed qualification.

The scenario, or context to which the model structure relates is as follows:

Two parties (individuals, agencies, groups, etc.) operate as goal-oriented entities within the same structure (an agency, government, marriage). One party is dominant over the other (subject) party, and has objectives in relation to the subject party's efforts. The problem area of interest to both parties is subject to direct manipulation only by the subject party; i.e., the dominant party must work through the subject party as its implementation arm. Conflict between the two parties comes about through a difference of desires. Two arenas of conflict are treated; conflict in goals, and conflict in desired response to the external problem.

Within the above context, three mechanisms for conflict resolution (reduction in difference in desires/perceptions of the parties) are identified:

Negotiation - mutual adjustment or compromise of positions by each party in the direction of the position held by the other party.

Education - one party, by maintaining some level of difference of opinion, causes a self-modification on the part of the other party.

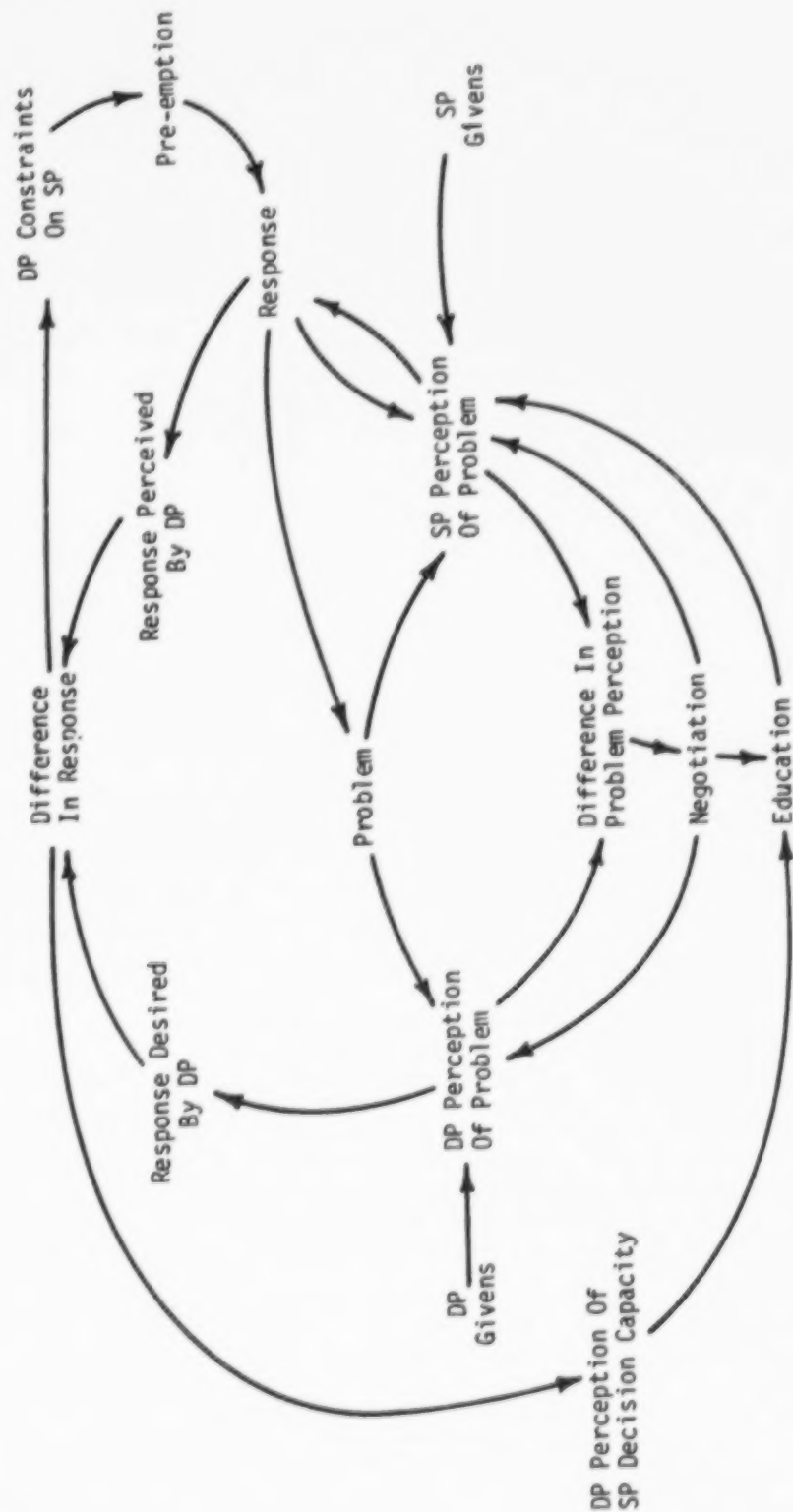
Pre-emption - the response of the subject party is arbitrarily "re-set" to that desired by the dominant party.

General Model Structure for Theoretical Model

The general structure for the interactions associated with dominant party (DP)-subject party (SP) conflict resolution is illustrated in Figure IV-5. The two arenas of interaction are response and perception of problem. As indicated in Figure IV-5, each party holds a perception of the problem which is determined by both the problem and the givens held by each party. The response to the problem (i.e., problem resolution) is generated as a result of the problem perception held by the subject party. Any conflict, such as it might be, results when the dominant party determines either the subject party's response or the subject party's problem perception to be insufficient and/or inappropriate. As illustrated in Figure IV-5, such conflicts are resolved through the utilization of the NEP (negotiation, education, and pre-emption) approach to the dominant party-subject party, conflict resolution.

Negotiation and education are used by the dominant party to elicit appropriate (as defined by the dominant party) problem perception on the part of the subject party; whereas, pre-emption is employed by the dominant party to obtain appropriate response, as measured by the dominant party, on the part of the subject party. When differences in problem perception between the dominant party and subject party are small, negotiation is the main form of conflict resolution with education and/or

FIGURE IV-5



GENERAL MODEL STRUCTURE FOR TWO PARTY, DOMINANT-SUBJECT PARTY, CONFLICT RESOLUTION

pre-emption playing little or no role. When the difference in problem perception is large, negotiation has little role to play and education and pre-emption become the prime vehicles of conflict resolution. That is, as illustrated in Figure IV-5, at large differences in problem perception, negotiation has little influence on changing the problem perception held by either party. Thus, the existence of a large difference in problem perception results in the stimulation of a large education effort by the dominant party to bring the problem perception of the subject party in line with that of the dominant party.

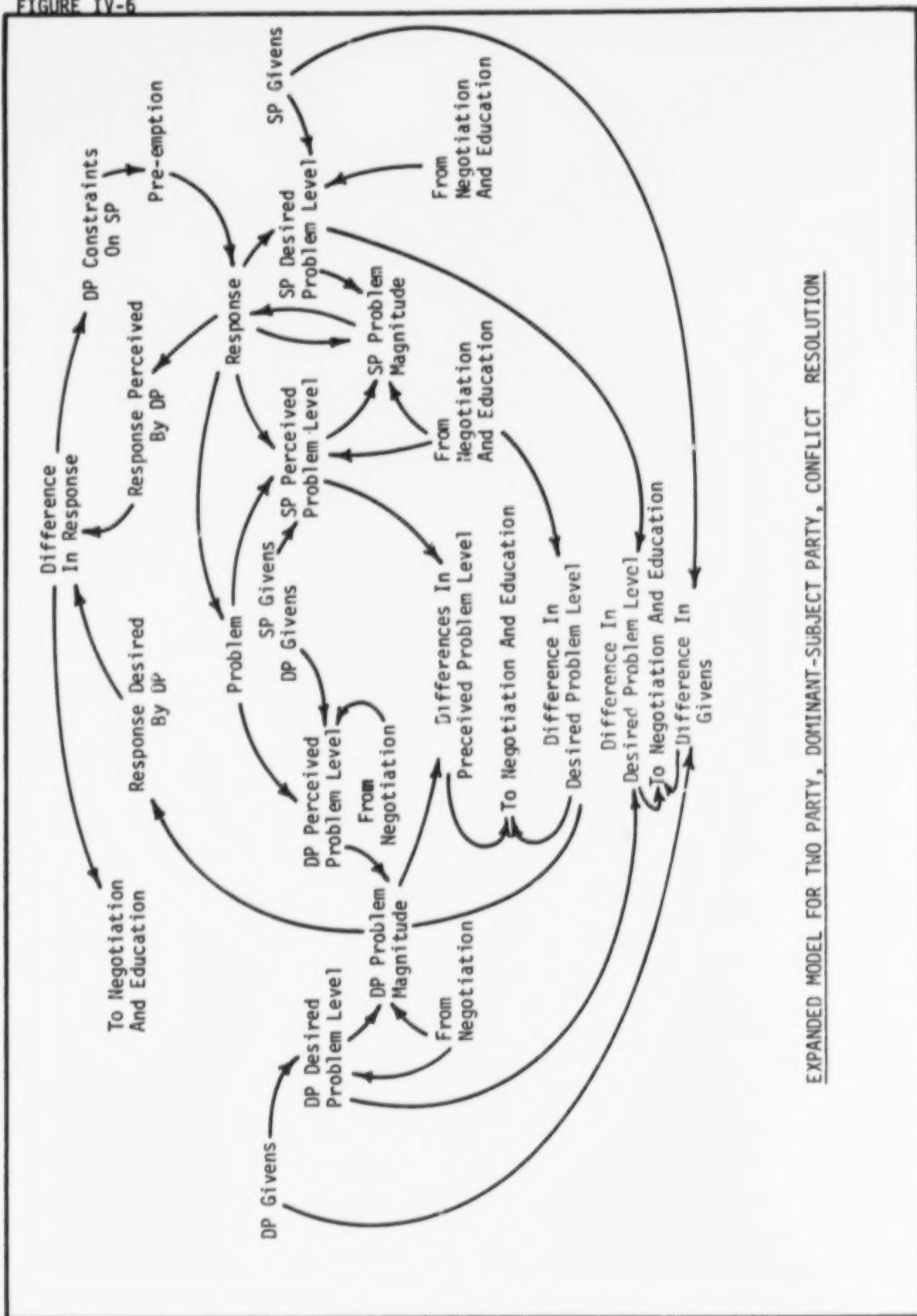
The difference in the response of the subject party as observed by the dominant party may or may not be in accord with the differences in problem perception. That is, it is entirely possible for response to be deemed appropriate in the face of inadequate problem perception and *vice versa*. If the difference in response is small, then any conflict resolution must be achieved through negotiation and/or education, stimulated, as described above, by the difference in problem perception. In the presence of a large difference in response (Figure IV-5) and a small difference in problem perception, conflict resolution is achieved by pre-emption and education of the subject party's response and perception, respectively, as determined by the difference in response and modified by the dominant party's perception of the subject party's decision capacity and the constraints placed on the latter by the former (See Figure IV-5).

Alternative modes, in addition to those defined above, of NEP conflict resolution can be determined through examination of the various control loops illustrated in Figure IV-5.

The true complexity of NEP conflict resolution is indicated in Figure IV-6 in which the DP and SP problem perception elements of the structure of Figure IV-5 have been expanded and are represented by the three component elements; i.e., perceived problem level, desired problem level, and problem magnitude. Negotiation and/or education may be stimulated by differences in perceived problem levels, desired problem levels, problem magnitude, or givens. The efforts of negotiation may be directed at the desired level, perceived level, or problem magnitude of the dominant party and the subject party. Education is directed at the same levels but only of the subject party. The subject party's response may act to effect pre-emption as discussed previously, and to reinforce or counteract the negotiation/education interactions stimulated by the preceding described differences in levels.

The critical aspects of NEP conflict resolution, as evidenced by this expanded model structure (Figure IV-6), are the selection of the specific element to be changed by negotiation and/or education (i.e., whether the conflict is being dominantly generated by differences in the perceived levels, desired levels, problem magnitude, or givens), the

FIGURE IV-6



EXPANDED MODEL FOR TWO PARTY, DOMINANT-SUBJECT PARTY, CONFLICT RESOLUTION

relative intensity of negotiation and education stimulated by given differences in level and/or response, and the difference in response required to elicit a pre-emptive act on the part of the dominant party. It is apparent that two-party conflict resolution of the NEP type involves a significant degree of trial and error to establish which levels, intensities of negotiation and/or education, and frequency of pre-emption result in reducing conflicts.

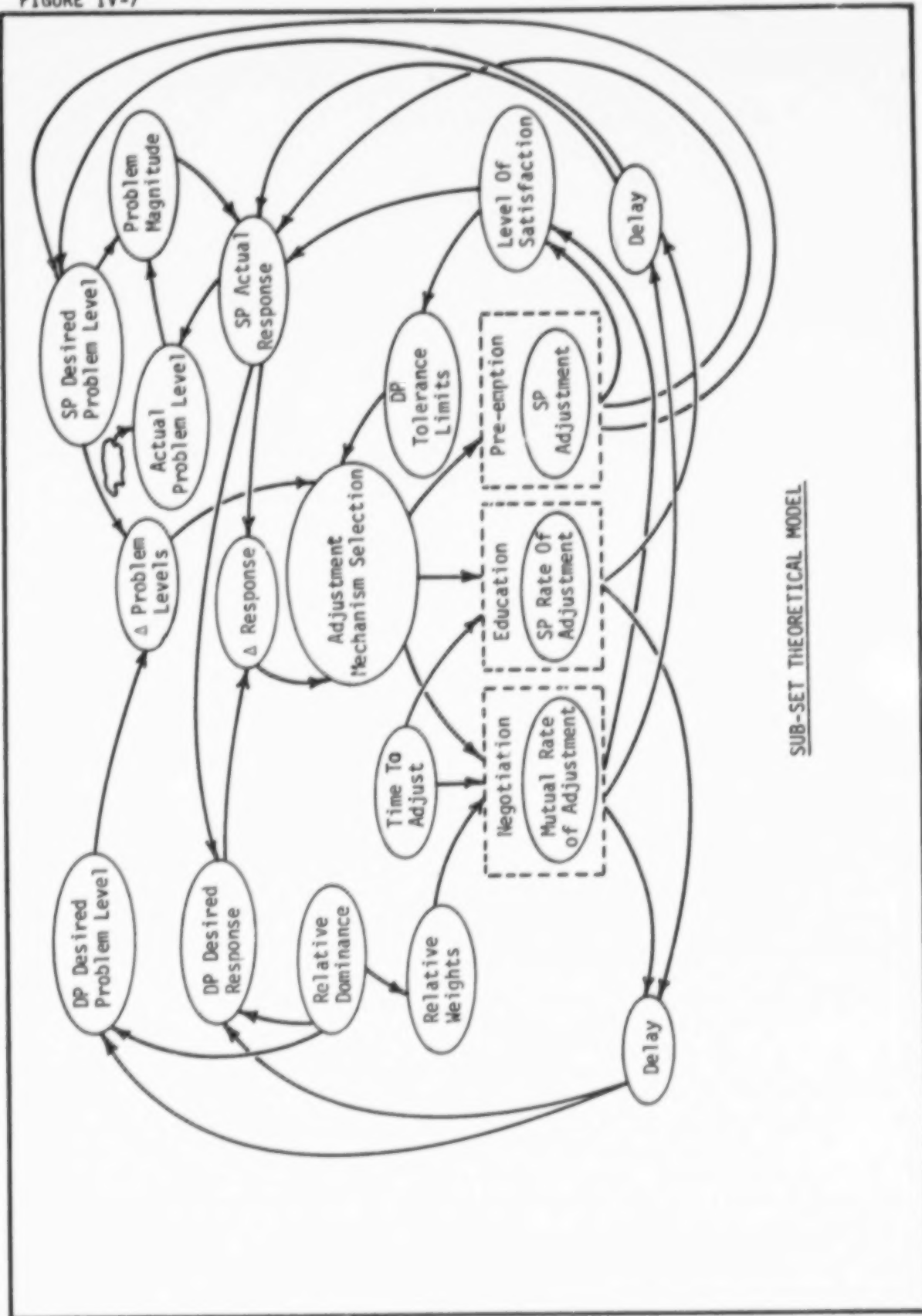
SUB-SET THEORETICAL MODEL STRUCTURE

Development of Sub-Set Model

The above over-all framework is the general structure in which the problem of dominant party-subject party interaction has been examined, and the basic modes of interaction (negotiation, education, pre-emption) derived. The complexity of the over-all framework precluded its transfer *in toto* to a computerized model. Accordingly, a "sub-set" model structure, simulating the dominant party-subject party interaction, was developed as a computerized model; as an experiment, the task of model development was given to an individual who participates in the researcher's "hierarchy" principally as a subject party. The results of this experiment are very instructive; even within the over-all framework, the perceptions of the nature of the interactions are quite distinct. Thus, for the subject party (sub-set model structure) (Figure IV-7) all factors (perception and response) are seen as susceptible to negotiation and education. Further, the dominant party is seen as "educable" with respect to goals and response by the subject party. Pre-emption is not always successful, independent of considerations of the alternatives and enforcement powers available to the dominant party. In contrast, in the over-all framework, negotiation and education are perceived as options available to the dominant party, and act with respect to goals. Pre-emption is directed at subject party response; a "successful" pre-emption depends upon the subject party's perception of the alternative courses of action available to the dominant party ("Can he fire me? Can he get the job done elsewhere?").

The manifold inconsistencies between the two structures illuminate a significant characteristic of hierarchies; different positions within the hierarchy hold, and act according to different models. A subject party, by virtue of acting upon its own model and perceptions, may be in conflict with the desires of the dominant party; thus, what is "right" and consistent to the subject party, is "wrong" and inconsistent to the dominant party. This process will eventually lead to a "crisis" situation, in which the "rules of the game" are re-defined by the dominant party. Such has been the case in the interactions between the State and Regional Boards; the two parties, acting on different models of behavior, came into conflict, leading to a re-definition, by the State Board, of the appropriate behavior on the part of the Regional Board (this may be termed "pre-emption of the subject party model").

FIGURE IV-7



SUB-SET THEORETICAL MODEL

Selection of Conflict Resolution Mechanisms

The differences in goals and response form the basis for conflict. The use of one of the three generic mechanisms of conflict resolution - negotiation, education, pre-emption - is based upon the type and the magnitude of the conflict between the two parties. In the model structure treated here, the dominant party desires a lower problem level and a higher rate of response than the subject party. Thus, differences in goals and response are the expected situation. Each party has an acceptable level of conflict or a certain tolerance to the identified differences. This acceptable level is a behavioral characteristic of each party. The subject party is defined as having an unlimited tolerance to conflict, i.e., is content to operate off its own problem magnitude independent of the dominant party. The dominant party has a finite limit to the amount of difference which will be tolerated before the pressure on the subject party is increased.

The tolerance limit permits classification of this conflict. If the difference in goals (Δ Goals) represents the difference in desired problem levels and the difference in response (Δ Response) represents the difference in desired and actual response, the possible outcomes can be illustrated in the form of a decision tree as shown in Figure IV-8. TOL_G and TOL_R are the respective tolerance limits for differences in goals and response held by the subject party.

Four possible outcome states, and associated conflict resolution mechanisms, are indicated by the decision tree:

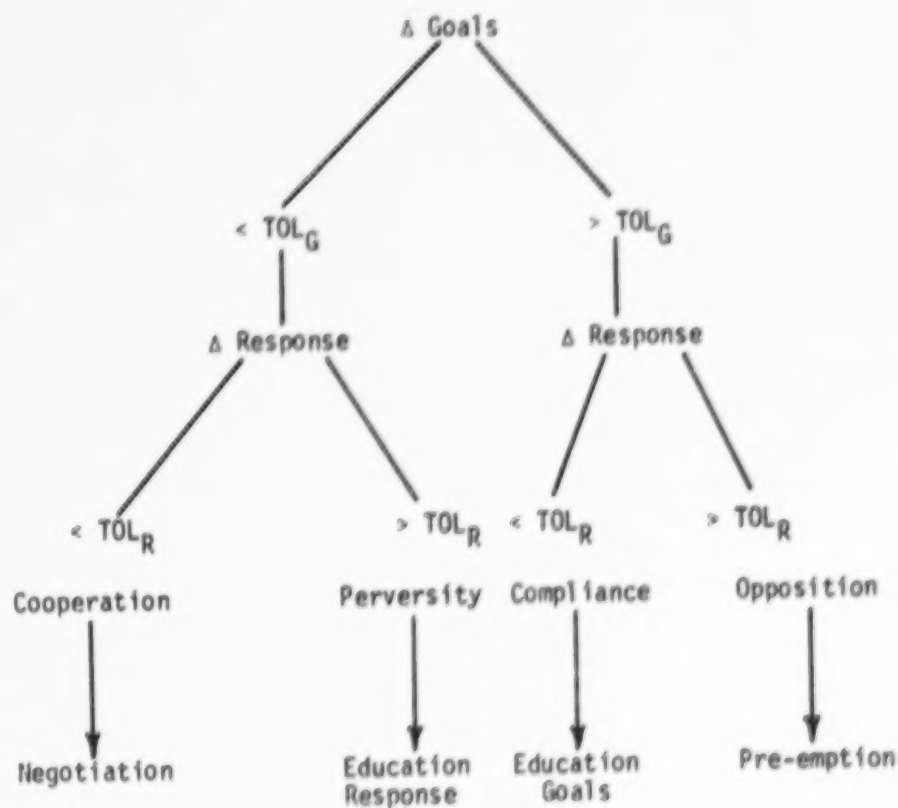
- Same goals, acceptable response/cooperation/negotiation.
- Same goals, unacceptable response/perversity/education with respect to response.
- Different goals, acceptable response/compliance/education with respect to goals.
- Different goals, unacceptable response/opposition/pre-emption.

Process of Negotiation

Negotiation is idealized as a mutual adjustment by each party in the direction of the other. To account for the dominant party having more influence or weight, the relative adjustments of each are made inversely proportional to the ratio: dominant party weight/subject party weight. This ratio is designated as the relative dominance.

The adjustment by each party occurs over a period referred to as the time to adjust. The rate of adjustment is defined as the adjustment - a fraction of the difference in response - divided by the time to adjust. The rate of adjustment feeds back to the desired and actual response and goals after a delay, as shown in Figure IV-7 and over time will affect the respective levels of response by each party.

FIGURE IV-8



ADJUSTMENT MECHANISM DECISION TREE

Educational Process

The over-all objective of education, from the dominant party point of view, is to convince the subject party to modify its own position. If the subject party desires to minimize conflict, it will be adjusting, trying to drive the differences to zero. However, in the case of education, the dominant party raises its standards for the subject party's performance to match the subject party's most recent adjustment. Thus, the differences in either goals or response are maintained at a constant level and thus, the subject party continues to adjust in the desired direction. Education can be with respect to goals or response depending upon which tolerance limit has been exceeded. The rate at which the subject party adjusts is defined as the total appropriate difference divided by the time to adjust. The feedback from the education process is to the desired problem levels or the response level depending upon whether the process is with respect to goals or response.

Pre-emption Process

The objective of the dominant party, when using pre-emption, is to make the subject party immediately conform to desired performance standards. In this case, both of the dominant party's tolerance limits have been exceeded. The subject party is forced to accommodate the entire difference in goals and response. Thus, the subject party's desired problem level is reduced by the amount Δ Goals and the response level is increased by the amount Δ Response. These changes occur essentially instantaneously, the time to adjust being one time unit.

EFFECTS OF CONFLICT RESOLUTION ON BEHAVIOR

In the previous discussion, the two parties were idealized to react to conflict in a purely mechanical fashion. It was implicitly assumed that there was a willingness to interact and that this prevented the breakdown of the process. To make the interaction more realistic, an expression of the satisfaction of each party with the process can be introduced.

A general level of satisfaction is a function of the cumulative state of the adjustment process at any given time. The level of satisfaction increases in proportion to the amount of time that negotiation is underway, reflecting the growing level of amicability. The level will be assumed to be unchanged during the time that education is being practiced. The level will decrease, and can be negative when the dominant party is pre-empting the subject party, indicating a growing hostility between the two parties. Pre-emption causes a reduction in level of satisfaction.

The level of satisfaction, due to its abstract nature, is not directly measurable. What is important is the relative change in the level of

satisfaction. For each party, a scale ranging from -10 to +10 is used reflecting that there are upper and lower saturation limits. The lower saturation level, -10, represents open hostility as evidenced by a large amount of propaganda, name-calling, and a general breakdown in communication. The upper end, saturation level +10, represents maximum happiness with the situation.

The level of satisfaction impacts on the dominant party by inducing a change in his tolerance limits. When the level of satisfaction is greater than zero, reflecting a past history of negotiation, a factor greater than 1.0 is applied to the tolerance limits. Conversely, when the level of satisfaction is less than zero, the tolerance limits contract.

A negative level of satisfaction impacts on the subject party by causing a reduction in its response. Thus, as the subject party becomes more hostile, he is assumed to be less willing to increase his response any further and a factor less than 1.0 is applied to the rate of change in subject party response. This incorporation of behavioral effects enables the system to become more responsive to a changing situation.

CONSTRUCTION AND TESTING OF THE COMPUTER MODEL

The sub-set theoretical model structure and concepts described above were translated into a form suitable for computer-processing through the use of the DYNAMO (Reference IV-1) language and compiler. Calibration of a descriptive model is usually done by adjusting parameters until the model behavior is characteristic of the historical behavior of the prototype. For the theoretical model, no prototype system specifically exists, outside of the general observations of two-party interaction. Accordingly, the model calibration process was one of parameter adjustment until the model behavior was in accord with the researcher's intuitive feelings and desires about two-party interaction. When this "calibrated" state was reached, a number of tests were run with the model, examining system behavior under various conflict resolution mechanisms. By appropriate adjustment of tolerance limits, any of the three mechanisms (pre-emption, negotiation, education) could be selected as the "pure" behavior mode for a given model run. The external problem level growth was an exogenous input to the model - a linear growth mode was investigated.

Results - Series I Tests

In this test series, the changes in the desired problem level of the subject party, when the dominant party has a linearly declining desired problem level, were investigated under the three modes. Results are presented in Figure IV-9. For the subject party, the two mechanisms that can induce a reduction in its desired problem level are education

THEORETICAL MODEL - SERIES I
CHARACTERISTIC BEHAVIORAL MODES FOR DESIRED PROBLEM LEVEL

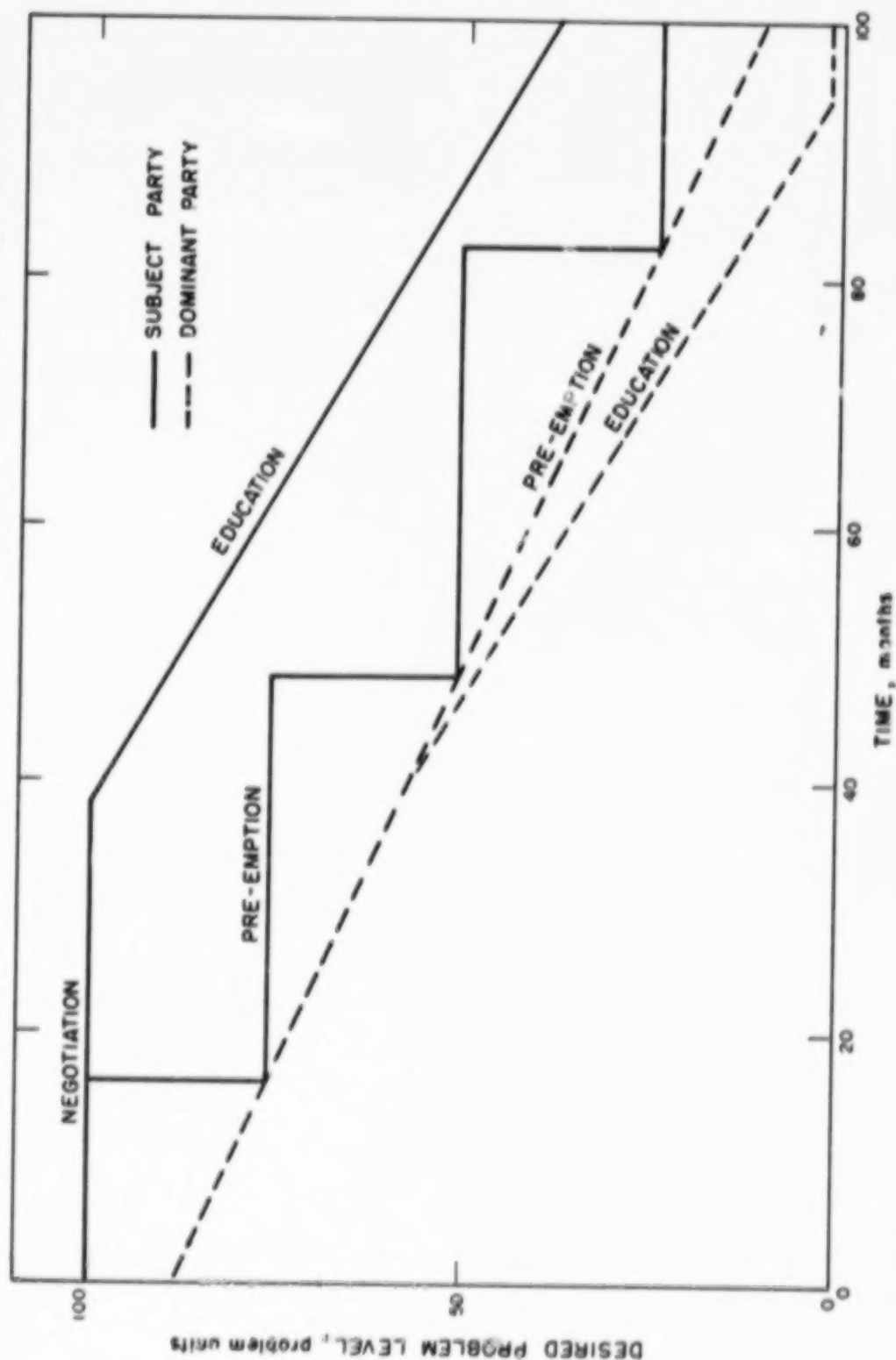


FIGURE IV-9

and pre-emption. Negotiation is not driven off the difference in goals so it produces no effect.

The education mechanism is triggered when the difference grows larger than the tolerance limit. Education was observed to produce a linear decline in the desired problem level of the subject party and also that of the dominant party. The rate of decline is dependent upon the difference in each party's goals and the time to adjust. The dominant party acts to maintain this difference by decreasing its desired problem level at the same rate as that of the subject party.

The use of pre-emption by the dominant party causes a sudden decline in the subject party goals. The frequency of pre-emptions was found to be dependent upon the magnitude of the tolerance of the dominant party and also whether the subject party response was out of line.

Series II Tests

Investigations of Series II were aimed at the response behavior of the subject party under the three conflict resolution modes. Results of the computer simulation runs are shown in Figure IV-10. The response is measured in problem units removed from the environment per unit time.

The process of negotiation causes an exponential rise in the subject party response. The rate of rise is dependent upon the relative weights of each party and the time to adjust.

The use of education by the dominant party causes a faster rise than negotiation, all other variables remaining constant, because the subject party is adjusting to remove the entire difference over the same time period. The scale of response is also dependent upon the rate at which the subject party responds to its own problem magnitude because the total rate of response is taken as the sum of the two.

The process of pre-emption causes a step increase in the response of the subject party. The incremental increases are equal to the difference in response. During the interval between the pre-empts, either negotiation or education occurs, but in this case, are not effective in avoiding further pre-empts because the difference continues to grow and again becomes greater than the acceptable level.

Series III Tests

A behavior mode for the system incorporating the effects of hostility was investigated in Series III. Subject party response over time after a continued series of pre-emptions on the part of the dominant party is indicated in Figure IV-11. Narrow tolerance limits on the part of the dominant party cause repeated pre-emption, after a small difference of

THEORETICAL MODEL - SERIES II
CHARACTERISTIC BEHAVIORAL MODES FOR RESPONSE OF THE SUBJECT PARTY

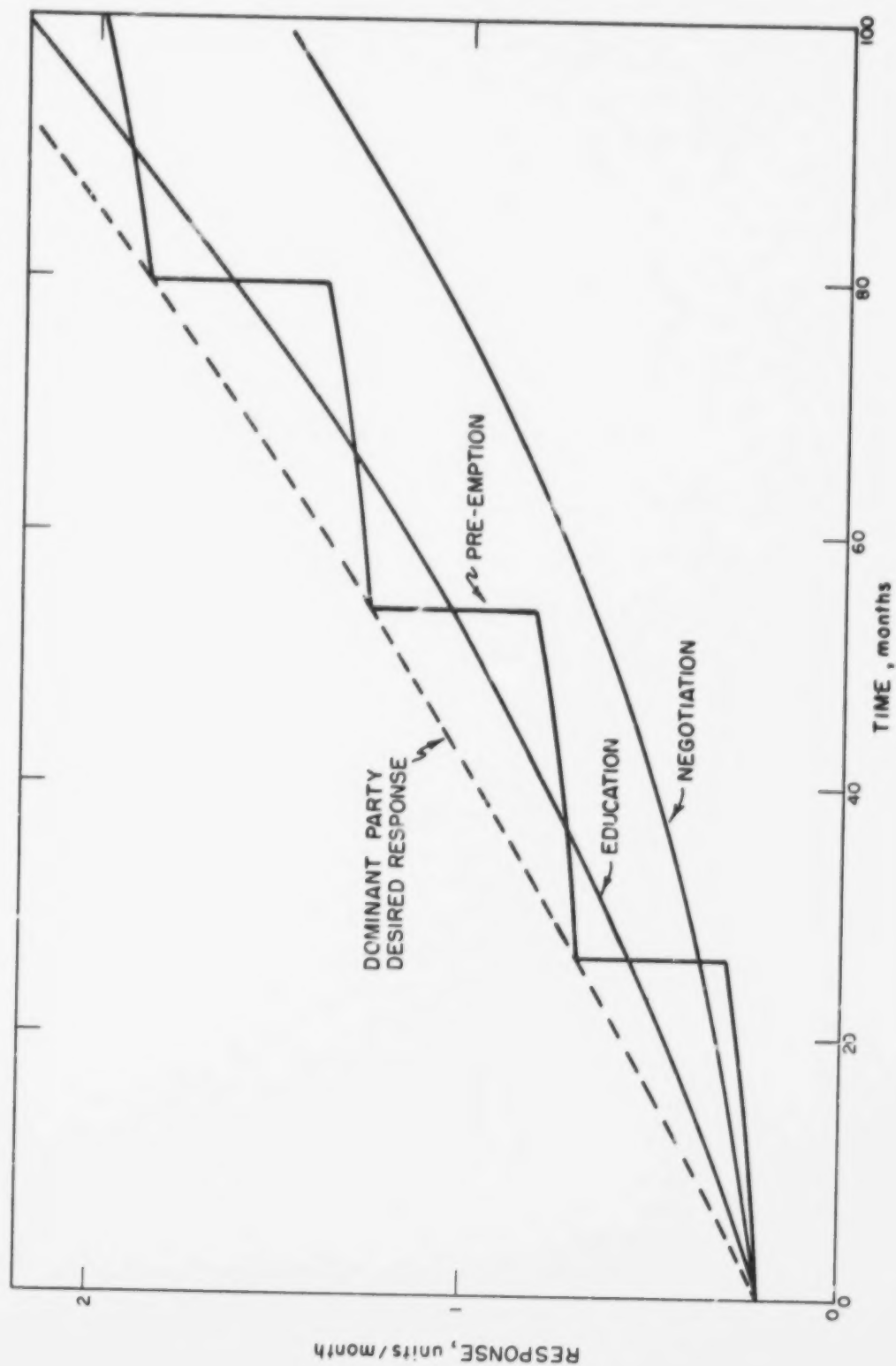
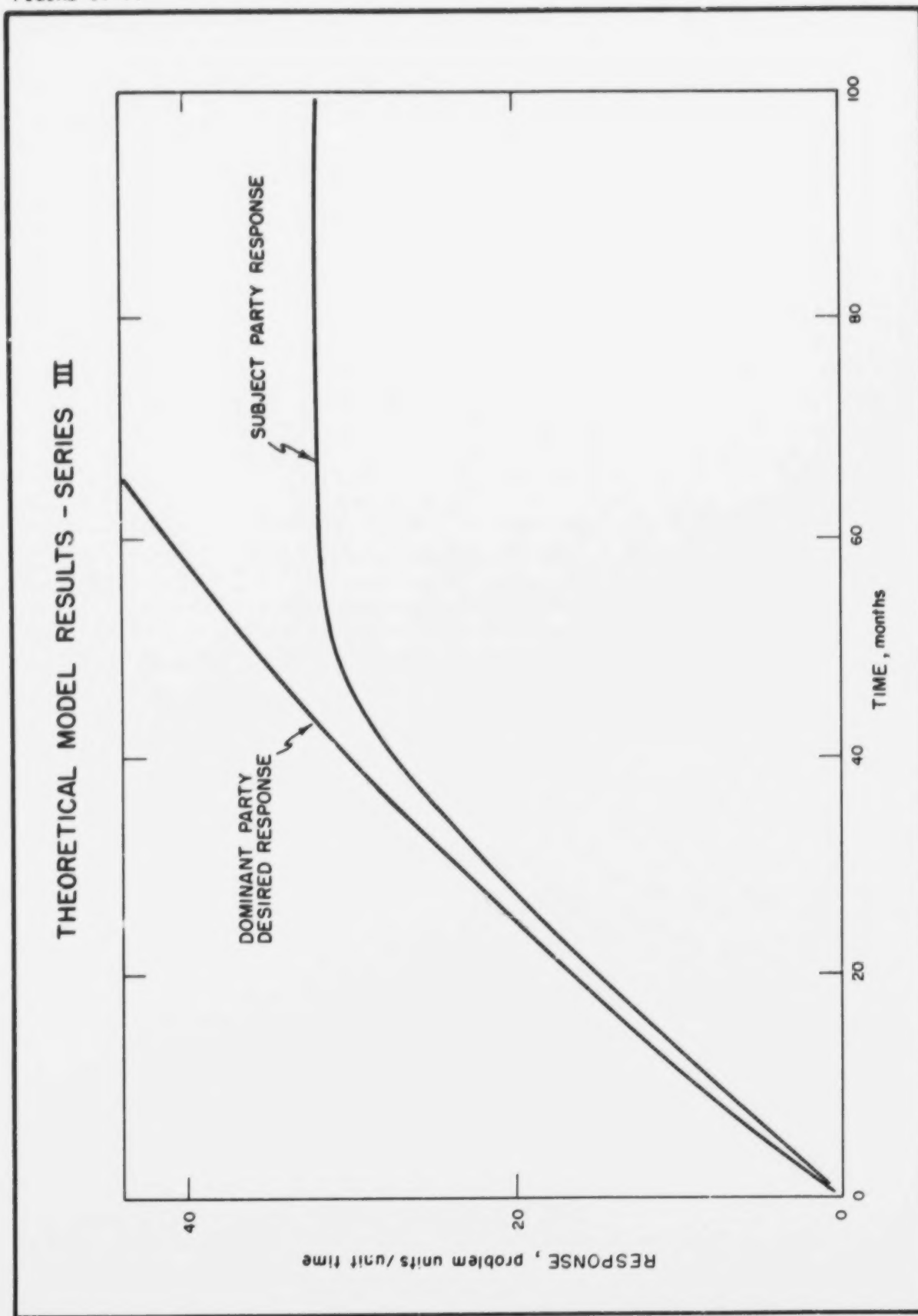


FIGURE IV-11



opinion. This pre-emption is initially effective, as seen by the close correspondence between desired dominant party response, and actual subject party response. As the level of satisfaction declines to the point of hostility due to the effect of the repeated pre-emptions, the subject party eventually refuses to modify his response in spite of the pre-emption. Under the given structure, the dominant party continually attempts pre-emption, due to the difference in response, and thus the level of satisfaction remains low, and the subject party continues to be unresponsive, and the difference grows over time. Such a situation is obviously unstable, and is a case of extreme conflict, in which the pre-emptive powers of the dominant party are being directly challenged by the subject party. In the sub-set model as defined, there is no mechanism to handle this situation; in the real world, such a situation can lead to destruction of the structure, or replacement of one or the other of the parties, depending upon their relative strengths.

CONCLUSIONS BASED UPON THE THEORETICAL MODEL

Drawing upon the above results and the insights gained in the construction of the theoretical model, the following conclusions with regard to the various behavior modes can be drawn:

- The negotiation and education modes cause gradual conflict resolution behavior. Under the negotiation mode, goals (problem levels) were not negotiated, only response. This suggests that the subject party prefers to retain as much control over policy (goals) as possible, and in a negotiation mode, will prefer to compromise on techniques (response).
- The introduction of hostility/satisfaction behavior into the process of two-party interaction can lead to an unstable situation if both parties are unresponsive and conflict develops. An extremely rigid dominant party (low tolerances) exacerbates this problem.
- The optimal behavior mode from the point of view of the subject party is clearly negotiation. Under this mode, the dominant party can be influenced, and the least effort on the part of the subject party is required under this mode. Under continual education, the subject party is placed in a continual response position, and, in effect, becomes an extension of the dominant party, whose will is exerted after a time delay.
- Education is the optimal mode of behavior for the dominant party. Subject party response is constant as long as the dominant party is careful to maintain tolerable differences with respect to the subject party. Negotiation is a slow process, requiring the

dominant party to adjust its own position, and implying equality between the parties. Under pre-emption, the dominant party is essentially resolving the problem itself, with no multiplication of effort from the system. Pre-emption appears undesirable since, once the pre-emption mode is initiated, it is usually recurrent, with attendant increase in hostility. The pre-emption mode is inherently unstable, leading to increasing differences, which must eventually be resolved outside of the defined model structure, on the basis of relative power.

- The existence of distinct models for appropriate and permissible behavior at different points within a hierarchy has been demonstrated. Behavior based on these distinct models can lead to conflict, confusion, and eventual re-structuring and re-definition within the hierarchy. (This general problem is discussed and dealt with in detail in the following chapter on the Role Awareness Program).

CHAPTER IV - LIST OF REFERENCES

- IV-1 Pugh, A.L., *Dynamo User's Manual*, 57 pp., Massachusetts Institute of Technology Press, Cambridge, Massachusetts, 1963.
- IV-2 *Systematic Analysis of Management Effectiveness of the Water Quality Control Board System of California*, report to the Office of Water Resources Research, Engineering-Science, Inc., Oakland, California, October 1969.

CHAPTER V

DESIGN AND CONDUCT OF ROLE AWARENESS PROGRAM

INTRODUCTION

The foregoing detailed study and analysis of an important decision-making process has value as more than an academic research exercise only if implemented in some manner. The behavioral study of an environmental management decision-making process provides a wealth of information and insight which can be of great importance to the process itself, if some procedure exists for providing feedback to that process in an effective manner. The publication of research results in a report is one such manner of providing feedback, but the lead time and delays inherent in this process often minimize the effectiveness of the feedback. Accordingly, a portion of this study was concerned with the development and application of a feedback device capable of acting within and upon the system being studied. In the eyes of the researchers, the functions of analysis and implementation are necessarily linked - the second is meaningless without the first, and the first is purely academic and untried, as well as unfulfilled, without the second.

The concept of the Role Awareness Program (RAP) has been developed as a procedure for linking analysis and implementation. Initially envisioned as a "training" program for water quality management decision-makers, the concept has evolved into one in which the model concepts developed in the analysis phase of the research are explored by the participants in the process; each participant is asked to define his own model, understand and communicate with the models of others, and in this manner become more aware of his own role in the decision-making process. A general design for such a program in the context of an environmental management decision-making process has been developed and is presented in the following section; it is hoped that this general design will be broadly applicable for groups involved in environmental decision-making. The specific sub-set of this general design, which was applied and tested within the context of the California Regional Water Quality Control Board system, is described subsequently; for a variety of reasons (political, budgetary, time constraints) the entire RAP design could not be tested within the California context.

GENERAL DESIGN FOR THE ROLE AWARENESS PROGRAM

The Problem

Decision-making relating to environmental management has become one of the most complex and "visible" processes in the public arena. What was formerly a process left by default to technical specialists, operating largely without public involvement or input, has become a multidisciplinary effort, continually monitored by "watchdog" special interest

groups representing a broad range of goals and beliefs. The technical merits of arguments advanced in environmental management cases are often quite complex, but no more than the manifold social/political/economic factors which are now being included for consideration. People of diverse backgrounds are required to act together, hopefully in a cooperative manner, in the decision-making process. Multi-agency or inter-disciplinary planning groups and study committees are now the norm rather than the exception in the environmental management field.

A significant problem in relation to the functioning of such "integrated" decision-making groups is that of the differing givens, models, perspectives, and styles of communication of the participants. There is in general no common ground upon which communication can take place; most frequently the same terms connote or denote different things to different individuals. If such groups are to function effectively as decision-makers, some means must be established whereby the members can transmit information accurately between themselves and others, and develop accurate insights about the system that they are manipulating.

The problem of assembling a collection of individuals into an effectively functioning group has been addressed in recent years by the fields of behavioral and management science. A number of techniques and approaches to resolving this problem have been developed and applied in various fields of business. Observation of most public hearings or meetings will show there has been little application of the techniques in the arena of public governmental decision-making; even less attention has been given to the problem of joint technical/non-technical group effectiveness.

The researchers, in their capacities as consulting engineers for various inter-disciplinary planning groups, have routinely had the opportunity to experiment with procedures designed to enhance inter-group communication and perception. The experience gained from these limited efforts, together with the research investigations performed in the current study, has led to the concept of the Role Awareness Program as an integrated tool for enhancing the communication and perception skills of technical/non-technical environmental management decision-making groups. The underlying concepts and structure of the over-all Role Awareness Program as evolved in this study, are described below.

Role Awareness Program - Protocols

The Role Awareness Program is a multi-technique, flexible format process, designed to enhance the skills and perceptions of individuals within a group having the following characteristics:

- The group is concerned in some manner with environmental planning, management, or control, in its broadest sense.

- The group is composed of, and/or deals with, technical and non-technical individuals of various orientations.
- The group operates within some formal or informal structure, i.e., its identity as a group, rather than a random assemblage of individuals, is acknowledged in some fashion.
- The structure, leadership, and style of the group is not so rigid as to preclude any individual thinking.

The design is based on the organizing concept of a "model" and its relationship to the communication process. Model as used here means the ideas that an individual holds about the nature of a system, against which he validates or measures his observations and choices related to that system. Each individual is presumed to hold such a model, either well or ill-formulated, explicit or not. The communication process is then formulated as follows:

model ↔ sender ↔ message ↔ receiver ↔ model

Any communication process involves at least two parties, the sender of a message and the receiver. Each message is related to a content inside the head of the sender and receiver, called the "model" for each party. The message is then formulated out of the sender's model, often with some speculation as to what the receiver's model is (viz., the teaching process). The receiver similarly interprets the message based on his own model, and possibly, speculates as to the sender's model. If the two models are similar, the communication process becomes much more explicit - if they are different, and the two models are mutually misunderstood, efficient communication does not take place. If, however, there is a means of describing and discussing each model, so that each party recognizes and understands the other individual's model, then it is possible to have an explicit communication process.

Against this background, the typical environmental management decision-making process has the following features:

- Environmental systems are complex, non-intuitive, dynamic, feedback-oriented.
- The concept of environmental management is really an intervention into the on-going process as it presently is constituted, possibly to "correct" other previous or potential interventions.
- In formulating such an appropriate intervention, the decision-making processes should have both an objective for system response, and a concept of the manner in which the system will respond to the proposed intervention (i.e., a predictive model).

- The typical decision-making process shows little formulation of objectives, little agreement upon objectives when so formulated, no clear concept of the system being manipulated and its response, and little testing of the validity of the objectives in terms of the "capabilities" of the system (i.e., questioning whether the system can, in fact, realize the given objectives).

Thus, the basic orientation of the Role Awareness Program is to provide individual decision-makers with the tools necessary to understand, validate and communicate their own models, and those of others, with a view towards establishing a means of assessing the various proposed interventions which are submitted to the group decision-making process.

Elements of RAP

The over-all RAP design consists of five basic elements: preliminary study of the system; design of workshop program; conduct of workshop program; evaluation; and follow-up.

- *Preliminary System Study* - In this element, the necessary background material for design of an appropriate program is collected, organized, and analyzed. This element may require, depending upon circumstances, extensive study, as in the present research, or simply review of pertinent documents and legislation. The principal emphasis in this element should be on the determination of the formal and informal structures and key personalities in the decision-making process. To the extent possible, a descriptive model (conceptual, rather than computerized) should be developed for the system being dealt with, because the major objective of RAP is to illuminate this model for the system participants.
- *Workshop Design* - The objective of this element is to select the techniques, format, materials, etc., from the battery of those available, which best suit the objectives, climate, and audience for the system. Inasmuch as the sponsoring force for RAP must come from within the system (i.e., there must be individuals within the system, in leadership positions, who desire and support the idea of RAP), it is important to determine the specific objectives and expectations of those individuals in the sponsor position. Sometimes, the explorations which RAP can engender will be in direct conflict with the desires of these individuals for specific results.

Any time and/or location constraints must be considered in the selection of a suitable RAP format. The ideal format is a weekend (Friday evening - Sunday afternoon) at a site removed from any

obvious involvement with the system under study (e.g., the conference rooms of the sponsoring agency would not be desirable). Alternative formats include one-day workshops, or a series of short (three-hour minimum) sessions over a week or two. In selecting a format it is important to strike a balance between the need for an intensive experience of participation, and the need for relaxation and reflection on the concepts being explored. For this reason, a two-day intensive workshop is probably the maximum that can be handled successfully by most individuals.

The optimal number of individuals participating similarly involves a trade-off between effectiveness for the individual, and reaching the largest number of individuals. Although different techniques can be selected based on the number of individuals present, those techniques which allow all present to participate actively, rather than as observers, are best for achieving attitude changes. A group of 20 people is about the maximum that can be accommodated successfully, for most techniques, by a single leader and provides sufficient range and depth of personalities and positions in the group. Larger groups can be accommodated by having more leaders, allowing for large-group sessions for lecture-type presentation, with small-group sessions for participatory exercises.

Among the available training techniques are: lecture; discussion sessions; case studies; role-playing exercises; simulations; and training laboratory sessions. Each technique has specific advantages and disadvantages for a given application; drawing upon a number of techniques provides variety for the participant, allows for a combination of structured and unstructured formats, and allows the most flexible program design. For the purposes of the over-all RAP design, three areas are to be explored:

- .. Transfer of cognitive information about the system.
- .. Exploration of attitudes, roles, and models within the system.
- .. Exploration of communication techniques *per se*.

The first area, transfer of cognitive information, is usually best explored through lecture and discussion formats, and is usually the first phase of a program. For the specific application of environmental management, the lecture and discussion focuses on the complex, dynamic nature of the ecosystem and social/political system. At this point, certain basics which must be established as tools for the remainder of the workshop are laid out: the concept of models; the concept of dynamic, feedback systems; subjective vs. objective behavior; normative vs. descriptive models; and counter-intuitive behavior of social systems. Inasmuch as the participants in the workshop generally do not have a common "language" for communication,

the above concepts are developed early, to provide such a commonality externally.

The second area of exploration is that of the roles, models, and attitudes which participants in the system hold. This is best accomplished through participatory exercises, in particular, role-playing and/or simulation. In a role-play situation, participants are asked to take part in a simulated "real-life situation", such as a Regional Board meeting, acting the roles they do not normally hold. Each participant must project himself into the feeling, style, and mood of another party. The emphasis is on direct experience of a different viewpoint; the greater the involvement in the role, the better. In simulation, on the other hand, the participant is asked to "be himself" in the simulated situation, and later receives feedback, either directly in the simulation process, or following, in a critique and discussion period. In either case, the discussion period which follows the exercise should focus on the different perceptions of one's own role and that of others which have been derived.

The third area touched on is the general topic of communication. Unlike the previous two areas, this can (and often advantageously should) be explored in a context which has little or nothing to do with the given structure or system, since the principles are general in nature. In the past two decades, a large body of experience with "laboratory training" or T-groups has been accumulated, directly relating to the problems of inter-personal behavior. One aspect of this training is to assemble a group of people in an unstructured situation, with no leadership direction, and allow the group to explore the pattern of its own organization and communication. This is commonly done in one-week or two-week sessions, since a certain level of discomfort is created initially, which must resolve itself productively over time. In terms of the Role Awareness Program, the use of unstructured, leaderless situations can be used to focus on the group process quite effectively, leading to the true examination of group goals, norms, and procedures. A further mark of the laboratory training technique is the immediate feedback that each individual can receive about his current behavior, i.e., the manner in which he communicates (verbally and non-verbally), participates, assumes or denies leadership, etc. The application of this technique requires a large measure of skill and sensitivity, particularly in a time-limited situation, since it can be quite threatening for an individual. For this reason, it is usually applied in situations where people who do not normally interact with one another form the group - hence, the group is a "safe" situation in which an individual can experiment with new styles of behavior.

Emphasis on communication should be made throughout the RAP, utilizing the concept of model-communication outlined earlier. In this manner, every statement made can be explored both as to content and form of communication. Such direct feedback is sometimes startling, and usually quite effective.

- **Conduct of the Program** - The conduct of the Role Awareness Program general design requires a balance between flexibility and structure - flexibility in order to be able to adapt rapidly to the character of a particular group, and structure because technical groups require some element of constraint in order to feel "comfortable" - purely unstructured situations are looked upon as a "waste of time". Thus, the individuals conducting the Role Awareness Program must be able to sense the immediate situation and status of the group, and respond accordingly, either with more structure or more flexibility. The leaders must similarly have a balance of technical and communications background and skills, in order to mesh properly, and respond appropriately with the group. Ideally, then, the program should be conducted by leaders able to "think on their feet" in the complex, dynamic situation of the RAP.

There is some advantage in having more than one leader for a group, particularly if the different leaders have differing styles, skills, and approaches. This adds to the variety of the program, and increases the potential for flexibility. If more than one leader is available, the group can be divided into sub-groups, but in this case, it is advisable to give each sub-group exposure to each leader.

The conduct of RAP is, of course, dependent upon the particular design and format established, but certain general guidelines exist:

- The program should move from the structured to the unstructured format, through the technical to the non-technical aspects of the problems at hand. That is, the initial stages should be such things as lectures, panel discussions, etc., all of which have some kind of structure, and do not place too great a stress on the individual to participate freely. The participatory mode must be nurtured carefully, or else it will be destroyed.
- An appropriate opening for the RAP is a lecture session, designed to show how the non-technical aspects of environmental management problems grow out of the technical aspects. At this time, a number of pertinent concepts needed later in the program can be developed.

- ** Following the lecture/structured portion (which may consume a morning session), small group discussion periods may be used to initiate the participatory aspects of the program. It is important at this time that the leader does not allow himself to be forced into the lecturer/expert role; the objective is for the group members to explore their own concepts and reactions to each other's concepts, under the idea that sufficient resident expertise already exists in the group itself. The results of these discussion sessions are not as significant as the processes taking place within them, both in terms of the group and for each individual; i.e., the discussion sessions have no particular objective or mission, other than the experience of effectively interchanging ideas.
- ** The following portion of RAP at this point can be an exercise involving direct participation, such as role-playing. If a role-play situation involving some familiar activity for the participants is to be used (e.g., a public hearing) it must be carefully designed beforehand to insure against obviously "unreal" situations. Such "unreality" is not of itself a problem, but, for those inexperienced in projecting themselves into other and different situations, "unrealities" distract from the main purpose of the role-play, and will be focused on as a means of avoiding playing the role. For this reason, it is often advisable to construct a totally artificial situation, one with which none of the participants are familiar. In this manner, it is possible to avoid focusing on procedural matters and inexactitudes and concentrate on the process of playing roles. The role-play session, which may last upwards of an hour, should be followed by discussion, criticism, and evaluation by the participants.
- ** Further discussion, exercises, and amplification of the preceding themes may follow as dictated in the specific design. In any case, the final session should be a large-group evaluation session, in which the RAP itself is discussed and criticized, and desires/plans for continuation or extension evolved.
- ** In general, the "mood" of RAP workshops should not be one of pressure - there is no need to fill every spare moment. Thus, such things as luncheon sessions, evening programs, etc., should be avoided - if the program has been properly designed, "free" time will be used for further, informal exploration.

- **Evaluation** - The fourth element of RAP is that of evaluation. As noted above, the final step in the conduct of the Role Awareness Program is a post-mortem, an evaluation of the process by the group. Such evaluation is valuable in a number of ways: it makes the participants feel a responsibility and involvement for the program; it provides the leaders with information for any further programs with the same group and it serves to help the evolution of the concept of the Role Awareness Program for other groups. Inasmuch as the purpose of the Role Awareness Program is to promote insight and attitude change, the evaluation should focus on these factors in the participants. The over-all significance of the program, of course, is determined by the resultant changes to the decision-making process which are brought about. It is possible for individuals to go through significant attitude changes within the format of the Role Awareness Program, only to act as usual in the familiar roles of the decision-making process. Thus, the immediate post-mortem evaluation should properly be followed up by an examination of the behavior of the decision-making group in the "real world". Pre- and post-RAP monitoring of the interactions taking place at a group meeting would be one method of "objectively" performing such evaluation.
- **Follow-Up** - The fifth element of the Role Awareness Program design is that of follow-up. The evolution of a mature problem-solving group is not achieved overnight, particularly where such a group has pre-existing norms, procedures, and goals. The intensive experience of RAP is a start towards achieving permanent attitude change, but only a start. Continuing contact with the decision-making group can insure that the concepts and attitudes developed by RAP do not decay, but rather are used to enhance the capabilities of the decision-making process. The follow-up element is probably the most difficult element of the over-all design to implement, inasmuch as the motivation to provide follow-up must come from within the group or its leaders, rather than externally. The commitment to follow-up implies a commitment to modifying the *status quo*, a risk that few established decision-making processes care to take. If possible, the problem of follow-up should be discussed with the sponsoring parties prior to the design and conduct of RAP, and a mutually satisfactory plan for follow-up devised. An on-going evaluation procedure extending some time past the end of the formal program may, in fact, be sufficient to keep some of the ideas of RAP viable within the decision-making process.

The above represents a general outline of the concepts of RAP, hopefully broad enough in scope to be applicable in a variety of contexts. The specific adaptation of the ideas, will, of course, depend upon the individuals and circumstances involved. As an example of such adaptation, the conduct of a Role Awareness Program for the California Regional Water Quality Control Board System is described below.

APPLICATION OF THE RAP

On 20 November 1970, a sub-set of the over-all RAP design was tested in an afternoon workshop session, lasting approximately four hours. Over 70 members and staff of the various Regional and State Boards participated. The initial concept of the researchers was to test the RAP in the format of a two-day workshop, with ten to 15 selected individuals from various groups within the water quality management decision-making process. When the concept of RAP was advanced to the State Board, however, the idea of using a portion of RAP at an already scheduled briefing session for Regional Board members evolved. Although the problems associated with this approach were manifold (large number of people, short time, structured situation with obvious hierarchy), the possibility of actually implementing the program with working decision-makers, rather than "testing" it with a select group, was very appealing. Accordingly, the format constraints were accepted, and a modification of the basic RAP design evolved to fit these constraints.

The basic element of the RAP sub-set design was a structured role-play session, "simulating" a Regional Board hearing on a cease-and-desist order. With the cooperation of one of the Regional Executive Officers, a detailed case problem was developed, involving roles for 15 individuals, including the nine Regional Board members, the executive officer and a member of his staff, the discharger, and various interest groups associated with the problem. A "staff report" on the problem was prepared and sent to the attendees, together with one specific role, and information relating to that role (Appendix B). The large number of individuals present precluded the direct participation of each one; accordingly, specific individuals were selected, in consultation with the State Board, to play the various roles - the remainder of the individuals present were observers, but were asked to identify with the role description included in the mailing.

The role-play session, after some initial uncertainty in starting, evoked excellent participation and involvement, and ran well beyond its scheduled time allotment. Following the role-play, the large group was divided arbitrarily into five smaller groups, for discussion sessions, lasting approximately 45 minutes. Participation was again good in the discussion sessions, but tended to focus on the "reality" of the simulation, rather than on the basic attitude changes and different roles which were illustrated. Following the discussion sessions, the large group session was again convened for summary discussions and participant evaluation. An evaluation form for the exercise was handed out; 28 replies were received. A summary of the replies is presented in Table V-1.

TABLE V-1
RAP EVALUATION RESPONSE

<u>Yes</u>	<u>No</u>	
		Has this exercise helped you gain any insight into:
20	8	(a) your role on the WQCB?
20	8	(b) the roles of other members of the WQCB?
12	16	(c) the goals of the WQCB?
14	14	(d) the objectives of the WQCB?
16	12	(e) the responsibilities of the WQCB?
10	18	(f) the interaction of various agencies with the WQCB?
19	9	(g) the decision-making process of the WQCB?
20	8	(h) the function and responsibilities of the staff?
6	22	(i) the relationship of the State and Regional Boards?
22	6	(j) tactics of various interested parties and how they might be used?
20	8	(k) your own "model" and "givens"?
9	19	(l) has playing the role changed your perception of communication?
10	18	(m) do you have a better feeling for the total picture of decision-making?
2	26	(n) do you have a different understanding of the discharger?
1	27	(o) do you have a different understanding of the role of the ecologist?
11	17	(p) did this experience help you to get a different view of water quality management?
Would you like to participate in more programs of this type?		
<u>Yes</u>	<u>No</u>	<u>No Response</u>
20	7	1
How could this program have been improved? - (a) more discussion, (b) meet with role players before program, (c) more detail - facts, (d) more time, (e) explain what program is for, (f) shorten role play.		

ANALYSIS OF RAP EXERCISE

The RAP exercise was both a success and a failure. The exercise was successful in terms of the participation, involvement, and general good reception by the attendees. The replies to the evaluation form indicate a general feeling that the perception of varying roles was enhanced, and that the exercise was generally valuable. The innovative character of the program was not rejected, rather it was enthusiastically received by many, in all likelihood easing the reception of any future programs of this type.

The exercise was a failure, however, in that it did not, in fact, address any of the significant dynamics of the decision-making process, as outlined in the previous chapters of this report. The response to the evaluation form clearly indicates this; the relationship between the State and Regional Boards, the total perception of the decision-making process, the goals and objectives of the water quality control boards, remain unexamined. Neither were the long-term technological, social, or economic implications of the decision-making process examined. The failure of RAP to explore these areas can be ascribed to two main factors; the format constraints of time and large number of individuals, and the informal, but strict control of the exercise by the State Board, limiting the scope of the potential explorations and discussions.

OVER-ALL COMMENTS AND CONCLUSIONS RELATING TO RAP

A number of problems, both ethical and operational, are involved in a process such as RAP. Among them are:

- In general, the group being dealt with is heterogeneous. The concepts of RAP may be far too sophisticated for some individuals, while some of the exercises and ideas may be elementary for those who have previously made such explorations. This "over-design" can be a very real problem in terms of high expectations on the part of the researchers; such may be the case in the ascription of failure to the RAP exercise conducted by the California Regional Board system.
- A corollary problem of the "unsophisticated" audience is that perceptions may be enhanced by too large a degree as a result of a "successful" RAP - this is particularly true when covert conflict and/or manipulation exists within the system, and becomes overt through the discussions of RAP. It is often advantageous for certain parties or interests to operate in a low-perception, low-sophistication environment to achieve their goals.
- The problem of developing permanent attitude change, of implementing the concepts and techniques demonstrated in RAP in the "real world" has already been mentioned, but should be

re-emphasized. As in any other "therapy" technique, the application of principles from the "safe" therapeutic environment in a risk situation is not always easy.

- The RAP itself can be an intense strain, and difficult for certain types of individuals unaccustomed to dealing with strong feedback. The leaders must be aware of such potential problems, and attempt to minimize or mitigate their effects. Similarly, any "maturation" of the group itself leads to a rather delicate "group feeling" which can easily be destroyed by too much stress or too many demands for performance. Again, it is the sensitivity of the leaders which is relied upon to sustain any gains made during the process of RAP.
- Any program such as RAP is essentially a manipulative one, taking individuals from one state of perception to another, differing state. The ethical problems of the leaders, both on their own and in acceding to the manipulation objectives of the sponsor organization, should not be ignored, but obviously must be answered on an individual, situation-specific basis.

In counter-balance to the above problems and difficulties, there exists the great opportunity to utilize a program such as RAP to assist in the development of an active, involved, effective and cohesive problem-solving group, aware of the implications of its own actions, and having the ability to communicate effectively, both internally and externally. It is the feeling of the researchers that the potential benefits in general outweigh the difficulties and disadvantages and that programs such as RAP be attempted in other contexts and locations.

CHAPTER VI

SOCIAL SYSTEM RESEARCH IN ENVIRONMENTAL MANAGEMENT

THE NATURE OF THE BEAST

Based on three years of extensive experience in treating environmental management problems from the aspect of their associated social systems, the researchers have developed a number of perspectives relating to work in social systems. These perspectives are presented as guides for evaluation of the current research, as principles defining the "nature of the beast" of social system research in environmental management, and in the hopes that other researchers will similarly share their views:

- Research into social systems relating to environmental management is an "art form" not generally considered "legitimate" by either the social sciences or the technical/engineering establishment. The technical/engineering establishment, exemplified by the major funding sources of such research, demands that the procedures used be "hard" measures, as if a physical system were being studied additionally, the results of the research must be "meaningful", in the sense that they should provide guidelines for manipulation of the social system in the traditional sense. For the social sciences establishment, the norms, historical references, disclaimers, etc., used in the study must conform to the academic procedures currently in vogue. Unfortunately, the reality of the situation is that it is not possible to satisfy either or both of the establishments and still do meaningful research - if researchers are not willing to be attacked constantly from both sides, the only resources available are either education of the respective establishments, or creation of a new "environmental social systems" establishment, with its associated norms, procedures, cults, and language.
- Conduct of social systems research, if other than academic, can lead to implementation resulting in modification of the system under study. An ethical stance demands that the researchers assume responsibility for their efforts. Such responsibility includes the duty to advocate and defend, and to report the work as totally as possible. The highly subjective nature of such research inevitably leads to pre-conception and manipulation of results. Thus, it is important that the researcher report his own subjective attitudes as background to the study.
- A further problem relating to reporting of the research effort is that the traditional formal research report is not well-suited to communicating the complex, co-acting, non-linear, "organic" nature of the research subject. Any linear form of communication

requires that the subject matter be conceptualized linearly; social systems do not have this character - they are a *Gestalt* form, as music or art. It is the experience of the researchers that the basic concepts of the research can be communicated quite readily in face-to-face communication situations aided by sequential construction of graphics, while it is very difficult to communicate in the written mode. Accordingly, the traditional "form" of the research report must, in general, be extended and shaped to fit the particular communication problem at hand.

- Social system research in environmental management, although operating at the boundaries of social sciences and engineering and in the gap between them, will, in general, involve an interface between personnel of the social science and engineering disciplines at some point in the conduct of the study. Vast differences exist in the normal modes of thinking and communication and in the ethics and approaches of the two fields. Over a two-year association, the researchers, both engineers and social scientists, still maintain distinctly different perceptions of the research. The advantages of the bi-disciplinary effort can be many, but the problems associated with the on-going relationship are arduous, and should be recognized.
- In general, research in social systems relating to environmental management falls into two main schools of thought, the normative (prescriptive) and the descriptive. The normative school of thought concerns itself with the manner in which things *should* function, and tends to accept the formal statements as real, e.g., an organization chart describes the organization. The descriptive school, on the other hand, is more concerned with defining the system as it *actually* functions; the normative aspects are of concern insofar as they represent constraints, goals, or hypocrisies of the real system. It is the opinion of the researchers that a normative approach has little value in examining social systems relating to environmental management; it is, however, quite common.

If the problems of social systems in environmental management are pursued sufficiently long and diligently, it is inevitable that social systems research will cease to be an "art form"; however, to act as though this is true at present is not only misleading but erroneous.

CHAPTER VII

GENERAL OBSERVATIONS AND MODEL ENVIRONMENTAL MANAGEMENT SYSTEM

RESEARCH EFFORT

This study was initiated on the premise that other states and governmental agencies would like to know why water quality management in California is good. Two years have been spent in the conduct of a detailed investigation of this environmental management decision-making process within the context of the State of California. The process is thoroughly understood by the researchers and has been faithfully, and hopefully comprehensively, reported by them. By studying the same system or other environmental management decision-making systems, further sums of money and manpower could be utilized to refine and continue the activities initiated during the current effort. Although the researchers would enthusiastically support the extension of social system research in environmental resources by others, they hold no particular desire to continue to expend their own efforts within a framework of research for the sake of research. Rather, having been afforded the opportunity to study and reflect upon the characteristics of environmental management decision-making, the only appropriate, and responsible, path for the researchers appears to be the design and attempts at implementation of a "most desirable" or "model" decision-making process and structure for environmental management. The "design" aspects of the model decision-making process are discussed herein. The attempts at implementation must necessarily be carried out in a "world" whose realities differ from those of the world of research.

MODEL ENVIRONMENTAL MANAGEMENT SYSTEM

Basic Perspectives and Characteristics of Existing Systems

Contemplation and evaluation of the findings, results, and implications of the past two years of research suggest that the following are the fundamental factors and concepts which must be dealt with in the design of an environmental decision-making process and structure.

- To be effective, an environmental management system must be firmly based on the realities of the ecological, social, political, technical, legal, and economic systems within which it is structured and operated;
- A system which does not reflect these realities will be ineffective and ultimately result in actions deleterious to both the environment and the encompassing systems.

- Even the best of the current environmental management decision-making processes are intended to relieve short-term manifestations of environmental problems rather than deal with the mechanisms giving rise to the manifestations.
- Resolution of manifestations rather than manipulation of mechanisms results in a cyclical pattern of alternating pollution control and pollution over time.
- The basic important tradeoffs involved in the act of manipulating the environment are neither recognized nor, in most instances, even suspected.
- The conflict inherently resident in hierarchical structures (State-Regional, Regional-Local, Federal-State) is seldom accepted as real in any formal situation; the myth of common and equivalent interest throughout a hierarchy is maintained;
 - This forces the hierarchy to an informal operating mode which tolerates recognition of the conflict and permits it to be dealt with.
- Informal operating modes inevitably eliminate certain participants; thus, inasmuch as no structure or philosophy has been willing to formally admit that different sectors have legitimately different interests, an effective hierarchy for environmental management decision-making has not been developed.
- Typically, the givens, assumptions, objectives, and models held by or basic to a decision-making process are rarely stated;
 - This precludes the assessment of the effectiveness of the decision-making process and associated structure in achieving its objectives.
- Environmental management hierarchical structures are typically mission-oriented, i.e., designed to meet their own objectives, as opposed to being designed to support and perpetuate a process whereby others can negotiate and achieve their objectives.
- Environmental decision-making processes focus on measures of performance which are visible but not necessarily relevant.

In essence, then, existing systems are generally acting to pursue their original mission (objective), possibly modified to some extent, and to insure their continued existence. The decision-making process and structure can be modified only with the expenditure of considerable time and effort, and maybe not even then, unless the system perceives that

its continued existence is threatened if it does not change. In most instances, the continued existence of a structure is taken as *a priori* evidence that the mission of the system is being pursued, and that the mission is relevant; thus, only infrequently is an objective-oriented system questioned with regard to its effectiveness in achieving its formal goals. It is also interesting to note that the seeking of goals is almost always considered appropriate; whereas the question of being permitted or having an arena within which to pursue goals is usually of concern only within legal circles.

FUNDAMENTAL GIVENS FOR A MODEL ENVIRONMENTAL MANAGEMENT SYSTEM

The examination, consideration, and evaluation of the concepts and bodies of information associated with ecology, social systems, and behavioral sciences has resulted in the formulation of the following givens which need to be included within the model environmental management decision-making process.

- The concept of degradation rates of the environment;
 - Background degradation rate.
 - Social degradation rate.
 - Perceived degradation rate.
 - Planned degradation rate.
- The concept of a rate of change in societal character.
- The concept of a hierarchical structure for public decision-making.
- The concept of the energy of sustenance.
- The concept of the limit of treatability.
- The concept of environmental resources management planning and implementation as a social process.

Degradation Rates of the Environment

The ecosystem, in its totality of the global level and below, is a "real" system created independent of, but subject to manipulation by, man. Conversely, unlike most man-created systems, the ecosystem can bring about the manipulation of man. Any environmental management system must, because of the totality of the ecosystem and the possible counter manipulations between man and the remainder of the ecosystem, take cognizance of the basic, critical behavior characteristics of ecosystems and

the associated implications with regard to other societal systems.

- There is a background degradation rate of the environment which is consistent with the elements of the Second Law of Thermodynamics, which occurs independent of, or in the absence of, man's activities. The rate of accumulation of energy in the environment and the uniformity of its distribution define the background degradation rate. The greater the total diffused energy throughout the system, the higher the entropy and the more degraded the system.
- There is an additional rate of environmental degradation generated as a result of societal activities. This social degradation rate of the environment which is a characteristic of the economic, technology, and production patterns and behavior of a given system, is always higher than the background rate; and is probably directly correlated with the available energy per capita.
- The perceived degradation rate of the environment is the social degradation rate as interpreted by the various interest groups which should and/or do participate in the decision-making process. The perceived degradation rate is highly dependent on the orientation and objectives of the particular interest group; for example, a conservation-oriented group will perceive a higher rate than an industrial-oriented group. A single agreed upon perceived rate is usually not obtained unless the decision-making process is very specifically designed to achieve such an objective.

The background, social, and perceived degradation rates of the environment, as well as the over-all rate of change in societal characteristics, are a part of existing environmental management systems, but are not explicitly recognized as such. In most instances, these rates are mistakenly included in the decision-making process as levels.

A key feature of the model decision-making process is the explicit utilization of a planned degradation rate of the environment. This planned degradation rate, being implicitly or explicitly measured in terms of the rate of diffusion of energy throughout an environment, is intimately related to the rate of change in societal character, and the background and prevailing social degradation rates. Additionally, the planned degradation rate is influenced by the current perceptions of the relations between the social degradation rate and the rate of change in societal character. Basically, then, the planned rate of degradation of the environment implies the rate of expenditure of the natural resources of a region, and/or the distribution of those resources, into, within, or out of the region to achieve selected

(implicit or explicit and formal or informal) levels of economy, technology and other societal benefits to which the goals of environmental management play a supportive role.

In situations currently typical of the United States, it is expected that the selected planned rate of degradation would fall between the current social and background rate of degradation. In other circumstances, such as developing countries or states, it is expected that the selected planned rate might well be in excess of the existing social degradation rate of the environment; this would enhance the rate of change in societal character in a perceived beneficial manner.

Hierarchical Structure for Public Decision-Making

The structure for public decision-making is a hierarchical, political one. Different aggregate levels can be defined, from the global, through Federal, State, Regional, downwards to the individual. Interactions take place principally between adjacent levels, but "short-circuiting" exists and is a fundamental attribute of the system. The nature of the interactions between levels in terms of environmental management may be thought of as allocations, constraints, and influences. Allocations of a resource, and constraints upon its use, flow from levels of greater political power to levels of lesser political power. Influence is the generic term for the feedback process from the lesser to greater concentration of political power, and is designed to affect the downward flow of allocations and constraints. Ideally, political power should increase at higher levels of the hierarchy; such is not the case. Many regional authorities have been created with significantly less power than the local entities they are supposed to coordinate and control. It will be assumed in the remainder of the discussion, however, that the typical flow of allocations and constraints is downward from Federal to State to Regional to Local, while the influence flow is upward. Thus, each level has successively less of a resource to allocate downward, while the constraints cascade downward (each unit of resource allocated downward is subject to all the constraints on its use imposed from above). At each level, the decisions on allocations and constraints are essentially political, in the sense that they are the result of the inter-play of various interests on that and other levels.

Energy of Sustenance and Limit of Tenability

Planning and implementation have traditionally been treated as a normative process in which what is defined as having to happen does happen. Planning and implementation of environmental management involves the tracking, manipulation, and response to three different rate functions; rate of change in societal character, social degradation rate, and planned degradation rate. The totality of resources required to adjust the social rate to the planned rate and the energy required to perpetuate the planned

rate, is defined as the energy of sustenance. A portion of the energy of sustenance is devoted to modifying the rate of change in societal character such that the social rate is, in fact, the planned rate. Because the planned rate reflects the historical understanding of the system at the time, it is inevitable that over time the energy of sustenance will increase to such a level as to be untenable in terms of proportion of the total available resource which must be invested to sustain the planned rate. At the limit of tenability, alternative planning, which results in a lower energy of sustenance, must be instituted. The best plan at any time is that plan which will result in the least consumptive investment of resources by the time the energy of sustenance reaches the limits of tenability.

Environmental Management as a Social Process

Environmental management has been treated formally as a technical process which has specific attainable goals. In this mode, the performance of environmental management has been somewhat dismal. Objectives have been achieved which have no relevance to the problems of environmental quality, a single community of interest has been assumed to exist, and it has been assumed that absolute, invariant environmental characteristics exist and can be achieved. At this juncture in time, it is very clear that environmental management is a social not a technical process. There is no single community of interest, rather there are communities of interest united around differing concepts and interpretations of priorities with regard to economic, social, technical, and political societal elements. Social processes as such are successful only when decisions important to the sub-systems are arrived at through negotiation and advocacy of counter and competitive positions, and the use of traditions of behavior of, and interaction between, the various communities of interest to provide the modulation of the process.

In the absence of the existence of a developed, formal social process for accomplishing environmental management decision-making, the process of resource allocation has been accomplished on a goal oriented basis. As evidenced by the fact that the major portion of environmental management activities is concerned with pollution control, rather than resource allocation, the traditional goal-oriented approach has favored the individual user of the resource. In order to initiate a social process for environmental management, it will be necessary to recover the resource and reestablish it, in either its original or an acceptable condition, in public ownership.

CONTEXT FOR THE PROCESS OF ENVIRONMENTAL MANAGEMENT DECISION-MAKING

Two key factors have been identified above as contributing to a process, rather than a mission orientation within a social system:

- The existence of an advocacy/adversary format.

- The existence of a body of tradition, embodying the concepts of "grey" areas, moving targets, and historical perspective.

In confronting the problem of developing a "model" planning process, it has been obvious that these factors are lacking in the currently existing planning agencies; each "plan" is an objective, it is not placed in a historical context, there is no separation of the advocacy and judicial/regulatory functions. Given that the only model of planning which is congruent with a descriptive view of reality is that model which maintains planning as a process, rather than as a mission, the basic problem of model design is that of institutionalizing the existence of a process. The most successful structure devised by man for institutionalizing a process within the social system is the judicial process; most other attempts soon fall into the mission-oriented, agency-survival mode. Accordingly, the scheme for institutionalizing the planning process for environmental management is based upon the existing structure for the judicial process; the need is to incorporate those structural features of the judicial process which insure its process orientation, into the existing contexts for environmental management planning and decision-making, and so insure that it too maintains a process orientation.

As noted above, the key structural features are those of the advocacy/adversary format, and the existence of a body of tradition (in which the judicial function is based). For the case of environmental management, three advocacy positions may be identified:

- **Preservationist** - assuming that the appropriated resource has, in fact, been recovered and is available for allocation, the preservationist advocacy position is simply not to allocate the resource but to maintain it - the position is essentially conservative in nature. In terms of system analysis, the preservationist advocate is driven off perceived constraints, rather than off optimization. The desire is to constrain the use of the resource, independent of any optima or benefits which could exist from its allocation.
- **Public interest** - the "public interest" advocacy role is that role which seeks to establish trade-offs, to define abstract concepts of "maximum utility to the community" - the stance maintained is an "objective" rather than a "subjective" one. The public interest advocate is seeking the "global optimum" for the social system under consideration, and is forced to establish ranking functions, priorities, commensurate measures of utility, and the like.
- **Individual interest** - the individual interest advocacy roles are those which have defined their own objective functions, and pursue their own local optima. They wish to obtain "their own piece of the resource" for use as they see fit, whether their stance be that of preservationist, public interest, corporate entity, resource developer, polluter, etc. It is the individual interest

role which has been successful in obtaining the implicit prior appropriations which have been made of the resource.

The above three roles represent the fundamental advocacy positions which exist in the arena of environmental management; they have always participated in the decision-making process, but with varying strengths, tools, and capabilities. Thus, the individual interests have had the major influence; they have dominated the technology, administrative control efforts, the media, etc. The successful pursuit of the local optima by the individual interests has been the driving stress for the current high-conflict, recovery of prior allocation state of the environmental management decision-making process. Both the preservationist and public interest advocacy roles have not traditionally had access to the tools or technologies available to the individual interests. Only recently are these advocacy positions establishing themselves as legitimate, although they still do not possess the tools to allow them to compete equitably with the individual interests.

Similarly, a body of tradition relating to environmental management does exist; unfortunately, it is never recognized or accepted, and has no legitimacy. Each environmental planning problem is seen as unique, covering a finite time scale, and not embodying any broad general principles. Prior to the current surge of environmental awareness, most environmental decision-making was consistent with the body of tradition that had evolved over time - as a consequence of this consistency, it was never necessary to articulate the tradition or norms. Currently, however, the advocacy interests of the preservation and public interest roles, have "challenged" the existing tradition - the typical response has been to assume that the tradition has never existed, to ignore it totally, and focus on the finite problems, rather than the broad patterns. Further, it is impossible to act in the context of environmental decision-making without contributing to the already-existing, "illegitimate" tradition; by its very nature, tradition is an evolutionary thing, integrating over time the norms, values, and practices of a society or societal sub-system.

Thus, the two necessary features to insure process orientation of the environmental planning function do exist; they are, however, illegitimate, unformalized, and most importantly, un-institutionalized - and therefore, ignorable. By institutionalizing these social realities, it should be possible to insure the maintenance of a process orientation.

INSTITUTIONALIZATION OF THE PROCESS OF ENVIRONMENTAL DECISION-MAKING

In the light of the above statements, institutionalization of the process of environmental decision-making requires:

- Explicit recognition of the advocacy function, with the three different roles formally represented.

- Acceptance of the existence of, and the importance of, the growing body of tradition relating to environmental planning and decision-making.
- Utilization of this tradition as the norm, and the basis for the judicial function.

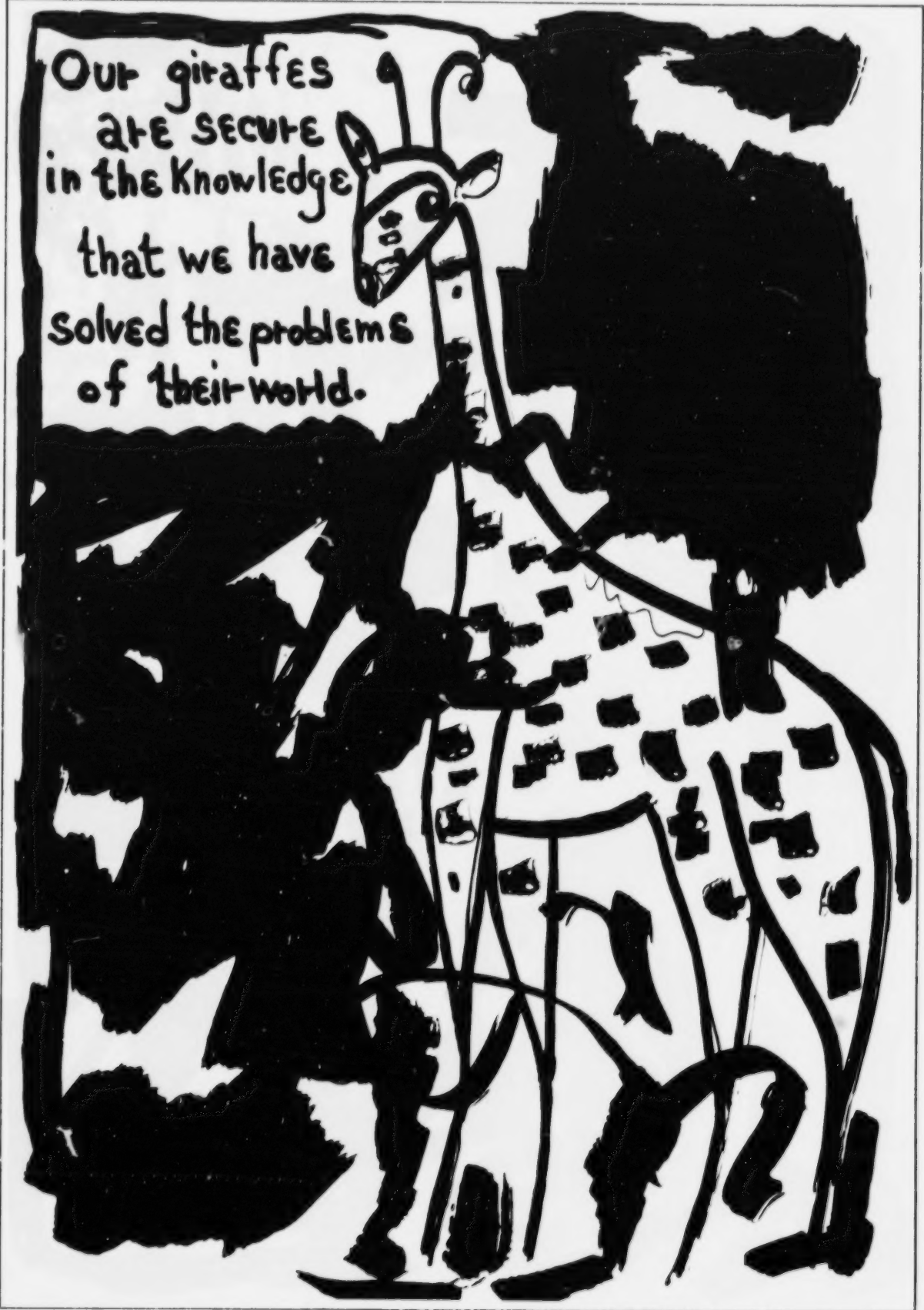
Accordingly, a model structure for the institutionalization of the process requires the establishment of the distinct and separate roles of the advocate and judge. Currently, the trend appears to be that the regulatory (judgmental) agencies are assuming the advocacy role for the public interest. The separation of these two functions is vital to insure that the process orientation is maintained. The judgmental function must find its base in the established and evolving traditions - otherwise, it becomes too responsive, and merges with the advocacy role. The over-riding concern of the judicial function must be the preservation of the process character of the interactions. This implies a faith in the process that allows the process itself to "make errors" - one does not scrap the process because, in the light of later tradition, it has not performed well. (The legal process has, over time, accepted a number of currently recognized "evils", e.g., segregation, but in spite of these perceived errors, the process has not been rejected. Similarly, religious tradition has not been rejected, in spite of Joan of Arc and Galileo. The process must be tolerant of its own past errors; this can be achieved only through historical perspective). The typical crisis-response cyclical pattern evidenced by the environmental decision-making process is directly related to the lack of historical perspective and the inability to accept "errors" as a portion of tradition - each new technological revelation about the physical world causes the system to start from scratch, rather than integrating the new information into an on-going process.

It is recognized that the process can "make errors", then, within the process, safeguards must be established, so that any errors are on the "retrievable" or revocable side - just as in the legal system it is deemed inadvisable to invoke capital punishment if even a "reasonable doubt" exists. The safeguards must be of two kinds: the ability to appeal decisions, and the insurance that errors are on the side of environmental preservation. The economic and social systems as "invented" systems, have greater resiliency than the ecosystem; hence choices must inherently favor the more delicate, less resilient system, and follow the preservationist ethic when doubt exists.

Implementation of the above concepts then, requires the establishment of what amounts to an "environmental judiciary" system. The current legal system is not adequate or appropriate for this task, inasmuch as its tradition is so at variance with environmental realities. This environmental judiciary system must entail the separation of advocacy and judicial functions, the recognition of tradition (and a scholarly ethic associated with

that tradition), the development of tools and technologies to make the three advocacy positions commensurate in terms of capabilities and the establishment of a safeguard procedure including appeal procedures and errors on the side of the preservationist ethic. The apparent trend of planning philosophy is directly away from this process approach; the former structure of the California Regional Water Quality Control Boards did explicitly recognize the existence of divergent advocate roles, while the current State-centered philosophy lumps the public interest advocacy role and the judicial function together. The researchers, therefore, in the implementation of the above ideas, intend to concentrate on the definition of and illumination of the existing and current traditions (cf. this report as an example), and the development of the tools and technologies to strengthen the advocacy roles of the preservationist and public interests.

Our giraffes
are secure
in the knowledge
that we have
solved the problems
of their world.



APPENDIX A

DESCRIPTIVE MODEL PROGRAM LISTING

```

//JN JN 111A7.0017),HALFS,MSGLFVFL=1
//JN JN 00 NSN=NSNAND,VOLUME=5FR=33333,UNIT=2311,DISP=RLD
//JN FXFC PGH=NYN24,CFGICN=755K
//SVSPPNT ON SVSOUT=4
//SVSUDUMP ON SVSOUT=4
//SVSIN ON 0
0      TEST RUN 12
SPEC  NT=4/LENGTH=474/PLTFR=0
NOTE  MODEL / STATE-REGIONAL BOARD SVSTW
NOTE  GENERATION FUNCTIONAL AREA
1      LG,K=LG,J+(NT)(RG,J,K)
2      LG=1LG
3      RG,KL=CRG1+(CRG2)(TIME,K)
NOTE  RESIDUAL BENEFICIAL USE LEVEL
1      RMIL,K=RMIL,J+(NT)(RMIL,J,K)
2      RMIL=1RMIL
3      RMIL,KL=(KRMIL,K)(LG,K)
4      KRMIL,K=CKR1+(CKR2)(TIME,K)
NOTE  POLLUTION LEVEL
1      APL,K=APL,J+(NT)(RGAPL,J,K-RDAPL,J,K)
2      APL=TAPL
3      RGAPL,KL=(KRGAPL,K)(LG,K)
4      KRGAPL,K=CRG1+(CRG2)(TIME,K)
NOTE  LEVEL OF TECHNOLOGY - EXOGENOUS - EXPONENTIALLY INCREASING
NOTE
2      LTECH=INTFC
3      LOGR=1LOGN(R)
4      AUX1=LOGR+(INTFC)/TAU
5      AUX2,K=(TIME,K)(LOGR)/TAU
6      INTFC,KL=AUX1*EXP(AUX2,K)
7      LTECH,K=LTECH,J+(NT)(INTFC,J,K)
NOTE
NOTE  IMPACT OF TECHNOLOGY - DIMENSIONLESS
NOTE
4      ITFCH,K=TARML(ITFCH,LTECH,K,0,10,1)
NOTE
NOTE  IMPACT OF ACTUAL POLLUTION ON PERCEIVED BENEFICIAL USE
NOTE
5      TAPL,K=TARML(APL,APL,K,0,1000,1000)
NOTE
NOTE  TWO ABOVE IMPACTS COMBINE MULTIPLICATIVELY TO AFFECT DECREASE
NOTE  IN PERCEIVED BENEFICIAL USE LEVEL
NOTE
6      ICPH,K=(CMAX1)(TAPL,K)(ITFCH,K)
NOTE
7      PRML,KL=(1-ICPH,K)(APML,K-PRML,K)          RATE OF DECREASE OF PAUL
NOTE
NOTE  LEVEL OF SOCIO-ECONOMIC DEVELOPMENT (ISEN) DRIVES INCREASE
NOTE  IN PAUL - HIGHER DEVELOPMENT-MORE WATER UTILIZED
8      ISEN,K=TARML(ISEN,LG,K,0,1000,1000)
NOTE
NOTE  RATE OF INCREASE OF PAUL
NOTE
9      IPML,KL=(ISEN,K)(APML,K)(CMAX3)
NOTE
NOTE  PERCEIVED BENEFICIAL USE LEVEL

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L      PRUL.K=PRUL.J+107*(CPBU.JK+IPRI.JK)
N      PRUL=PRUL
NOTE#
NOTE# MINIMUM RESIDUAL PRUL, INDEPENDENT OF POLLUTION, TECHNOLOGY
NOTE#
N      APRUL.K=MAX(PRUL.K,PRULNN)
NOTE#
NOTE# DIFFERENCE BETWEEN DESIRED AND PERCEIVED BENEFICIAL USE
NOTE# DRIVING FORCE FOR PROBLEM AWARENESS
NOTE#
N      DIFRI.K=PRUL.K-APRUL.K
NOTE#
NOTE# CONSTANTS AND TABLES FOR GENERATION FUNCTIONAL AREA
NOTE#
NOTE# AND GENERATION FUNCTIONAL AREA
NOTE# FUNCTIONAL AREA FOR DETERMINATION OF DESIRED LEVEL OF
NOTE# WATER QUALITY
NOTE#
NOTE# LONG-TERM CHANGE IN LEVEL OF AWARENESS DUE TO DIFFERENCE
NOTE# IN DESIRED AND PERCEIVED BENEFICIAL USE. SHORT-TERM CHANGES DUE
NOTE# TO PROPAGANDA IMPACTS
NOTE#
NOTE# LEVEL OF AWARENESS
NOTE#
L      LAW.K=LAW.J+107*(CAM.JK-PAW.JK)
N      ALAW.K=MAX(LAW.K,LAWNN)
N      ALAW.K=MIN(ALAW.K,LAWMX)
N      LAW=TLAW
NOTE#
NOTE# IMPACT OF DIFRI ON INCREASE IN AWARENESS
NOTE#
N      DIFRI.K=YARML(DIFRI.K,0,1000,100)
N      I.K=(CMAX?)(DIFRI.K+INFI.K+INFP.K)
NOTE#
NOTE# RATE OF INCREASE IN AWARENESS
NOTE#
N      CAM.KL=(I.K)*(ALAW.K)
NOTE#
NOTE# NATURAL ATTRITION IN AWARENESS
NOTE#
N      PAW.KL=(ALAW.K-LAWNN)/DPC
NOTE#
NOTE# INTEREST GROUPS DEVELOP OWN AWARENESS THROUGH SIMPLE AMPLIFICATION
NOTE# ON GENERAL LEVEL OF AWARENESS. AMPLIFICATION FACTORS ARE
NOTE# BEHAVIORAL CONSTANTS FOR EACH OBJECTIVE GROUP.
NOTE#
N      PAW5.K=(IK5)*(ALAW.K)
N      PAW1.K=(IK1)*(ALAW.K)
N      PAW2.K=(IK2)*(ALAW.K)
NOTE#
NOTE# IMPACT OF PERCEIVER AWARENESS ON CHANGE IN DESIRED LEVELS
NOTE#
N      IPAW5.K=YARML(PAST5,PAW5.K,0,20,1)
N      IPAW1.K=YARML(PAST1,PAW1.K,0,20,1)
N      IPAW2.K=YARML(PAST2,PAW2.K,0,20,1)
NOTE#

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NOTE DESIRED LEVEL IS MEASURED IN POLLUTION UNITS. HIGH DL, LOW QUALITY.
 NOTE NEED AUXILIARY VARIABLE FOR OUTPUT DISPLAY, BUT DL IS DRIVING
 NOTE FORCEF. AUXILIARY VARIABLES ARE QUALITY LEVELS
 NOTE CHANGES IN DESIRED LEVELS FOR INTEREST GROUPS
 NOTE DESIRED LEVELS (OF POLLUTION) FOR INTEREST GROUPS

L	A5.K=A5.J+(DT)(RA5.JK)	STAFF DESIRED LEVEL	00000128
L	A1.K=A1.J+(DT)(RA1.JK)	1 DESIRED LEVEL	00000130
L	A2.K=A2.J+(DT)(RA2.JK)	2 DESIRED LEVEL	00000132
R	RA5.KL=((PAW5.K)(AS.K)(MAXC5)		
R	RA1.KL=((PAW1.K)(A1.K)(MAXC1)		
R	RA2.KL=((PAW2.K)(A2.K)(MAXC2)		
N	AS=1A5		00000134
N	A1=1A1		00000136
N	A2=1A2		00000138
NOTE	SA/RP/ED INTEGRATION OF INTEREST GROUP OPINION		00000140
NOTE			00000142
A	TWT3A.K=PR13A.K+PR23A.K+W3A.K	TWT, WT, 3	00000144
A	TWT4A.K=PR54A.K+PR14A.K+PR24A.K+W4A.K	TWT, WT, 4	00000146
A	TWT5A.K=PR15A.K+PR25A.K+W5A.K	TWT, WT, 4	00000148
R	A4AG.KL=((PR54A.K)(AS.K)+(PR14A.K)(A1.K)+(PR24A.K)(A2.K)+(W4A.K)(A		
R	4N.K))/TWT4A.K		
R	A5AG.KL=((PR15A.K)(A1.K)+(PR25A.K)(A2.K)+(W5A.K)(A5N.K))/TWT5A.K		
R	A3AG.KL=((PR13A.K)(A1.K)+(PR23A.K)(A2.K)+(W3A.K)(A3N.K))/TWT3A.K		00000150
N	A3AG=1A3N		
N	A4AG=1A4N		
N	A5AG=1A5N		
NOTE	THREE-WAY MUTUAL PERCEPTIONS		00000152
NOTE			00000154
A	DLA45.K=A4AG.JK-(ER1.K)(A5AG.JK)		00000156
A	DLA54.K=A5AG.JK-(FR2.K)(A4AG.JK)		00000158
A	DLA35.K=A3AG.JK-(FR3.K)(A5AG.JK)		00000160
A	DLA53.K=A5AG.JK-(FR4.K)(A3AG.JK)		00000162
A	DLA34.K=A3AG.JK-(FR5.K)(A4AG.JK)		00000164
A	DLA43.K=A4AG.JK-(FR6.K)(A3AG.JK)		00000166
A	DLA3.K=(DLA35.K+DLA34.K)/2		00000168
A	DLA4.K=(DLA45.K+DLA43.K)/2		00000170
A	DLA5.K=(DLA53.K+DLA54.K)/2		00000172
A	X3A.K=TARHL(DLA3T,CLA3.K,-100,100,20)		00000174
A	W3A.K=C3A0X3A.K		00000176
A	X4A.K=TARHL(DLA4T,CLA4.K,-100,100,20)		00000178
A	W4A.K=C4A0X4A.K		00000180
A	X5A.K=TARHL(DLA5T,CLA5.K,-100,100,20)		00000182
A	W5A.K=C5A0X5A.K		00000184
L	ER1.K=ER1.J+(DT)(7)		00000186
L	FR2.K=FR2.J+(DT)(7)		00000188
L	FR3.K=FR3.J+(DT)(7)		00000190
L	FR4.K=FR4.J+(DT)(7)		00000192
L	FR5.K=FR5.J+(DT)(7)		00000194
L	FR6.K=FR6.J+(DT)(7)		00000196
N	FR1=1		00000198
N	FR2=1		00000200
N	FR3=1		00000202
N	FR4=1		00000204
N	FR5=1		00000206
N	FR6=1		00000208
N			00000210
N			00000212
N			00000214

N	ERG=1	00000216
NOTE	WATF ADJUSTMENT PROCESS	00000218
NOTE	STATE BOARD PRE-EMPTION WHEN DIFFERENCE GREATER THAN	00000220
NOTE	A GIVEN TRIGGER VALUE	00000222
L	WASN.K=MAX(WASN.J+(OT)(WASN.JK)	
L	WA4N.K=MAX(WA4N.J+(CT)(WA4N.JK)	
L	WASN.K=MAX(WASN.J+(OT)(WASN.JK)	
N	WASN=IASN	
N	WA4N=IA4N	
N	WASN=IASN	
A	ASN.K=MAX(WASN.K,ACONST)	
A	A4N.K=MAX(WA4N.K,ACONST)	
A	ASN.K=MAX(WASN.K,ACONST)	
NOTE		00000236
NOTE	TRIGGER VALUE - VARIABLE PERCENT OF AGGREGATE OPINION	00000238
A	ASTRG.K=TABHL(TASTRG,ATAG,JK,0,200,20)	00000240
A	WASTRG.K=IASTRG.K(ATAG,JK)	
NOTE		00000244
N	WASN.KL=CLIP(WASN1.K,PA3N2.K,CLA35.K,WASTRG.K)	00000246
A	WASN1.K=IA3AG,JK-WASN.K(OT)	
A	WASN2.K=(WRA35.K)(-CLA35.K/TRA34.K)+(WRA34.K)(-CLA34.K/TRA34.K)	
NOTE		00000254
NOTE	WRA35,WRA34 CAN BE SET TO REPRESENT LONG-TERM POLICY OF	00000256
NOTE	FAVORING EITHER EN OR RB, OR DRIVEN OFF PERCEIVED DIFFERENCE	00000258
NOTE	IN PROBLEM PERCEPTION (HIGH WT. - LITTLE DIFFERENCE)	00000260
NOTE		00000262
N	WA4N.KL=CLIP(WA4N1.K,RA4N2.K,CLA45.K,WASTRG.K)	00000264
A	WA4N1.K=IA3AG,JK-WA4N.K(OT)	
A	WA4N2.K=(WRA45.K)(-CLA45.K/TRA44.K)+(WRA44.K)(-CLA44.K/TRA44.K)	
NOTE		00000272
N	WASN.KL=CLIP(WASN1.K,PA3N2.K,CLA35.K,WASTRG.K)	00000274
A	WASN2.K=(WRA35.K)(-CLA35.K/TRA34.K)+(WRA34.K)(-CLA34.K/TRA34.K)	
A	WASN1.K=IA3AG,JK-WASN.K(OT)	
NOTE		00000282
NOTE	AVERAGE LEVEL	00000284
A	AVAN.K=(W3)(A3AG,JK)+(W4)(A4AG,JK)+(W5)(A5AG,JK)	
NOTE	PROPAGANDA GENERATION (SIMPLIFIED)	00000288
NOTE		00000290
A	DA5.K=A5.K-A4N.K	00000292
A	DA14.K=A1.K-A4N.K	00000294
A	DA15.K=A1.K-A3N.K	00000296
A	DA16.K=A1.K-A5N.K	00000298
A	DA23.K=A2.K-A3N.K	00000300
A	CA24.K=A2.K-A4N.K	00000302
A	DA25.K=A2.K-A5N.K	00000304
A	PSA.K=TABHL(P5AT,DA5.K,-200,200,40)	00000306
A	P13A.K=TABHL(P13AT,DA13.K,-200,200,40)	00000308
A	P14A.K=TABHL(P14AT,DA14.K,-200,200,40)	00000310
A	P15A.K=TABHL(P15AT,DA15.K,-200,200,40)	00000312
A	P23A.K=TABHL(P23AT,DA23.K,-200,200,40)	00000314
A	P24A.K=TABHL(P24AT,DA24.K,-200,200,40)	00000316
A	P25A.K=TABHL(P25AT,DA25.K,-200,200,40)	00000318
A	PR54A.K=TABHL(PR54AT,PSA.K,0,100,10)	00000320
A	PR13A.K=TABHL(PR13AT,P13A.K,0,100,10)	00000322
A	PR14A.K=TABHL(PR14AT,P14A.K,0,100,10)	00000324
A	PR15A.K=TABHL(PR15AT,P15A.K,0,100,10)	00000326


```

A PR23A,K=TABLE (PR23AT,P23A,K,0,100,10)
A PR24A,K=TABLE (PR24AT,P24A,K,0,100,10)
A PR25A,K=TABLE (PR25AT,P25A,K,0,100,10)
A WRA35,K=TABLE (WRA35T,CTIME,K,0,300,30)
A TRA35,K=TABLE (TRA35T,CTIME,K,0,300,30)
A WRA34,K=TABLE (WRA34T,CTIME,K,0,300,30)
A TRA34,K=TABLE (TRA34T,CTIME,K,0,300,30)
A WRA43,K=TABLE (WRA43T,CTIME,K,0,300,30)
A TRA43,K=TABLE (TRA43T,CTIME,K,0,300,30)
A WRA45,K=TABLE (WRA45T,CTIME,K,0,300,30)
A TRA45,K=TABLE (TRA45T,CTIME,K,0,300,30)
A WRA43,K=TABLE (WRA43T,CTIME,K,0,300,30)
A TRA43,K=TABLE (TRA43T,CTIME,K,0,300,30)
A WRA44,K=TABLE (WRA44T,CTIME,K,0,300,30)
A TRA44,K=TABLE (TRA44T,CTIME,K,0,300,30)
A CTIME,K=CSCALE*CTIME,K
NOTE
NOTE PERCEIVED LEVEL OF POLLUTION FUNCTIONAL AREA
A R5,K=(AMP5) (APL,K)
A R1,K=(AMP1) (APL,K)
A R2,K=(AMP2) (APL,K)
A TMT3B,K=PR13N,K+PR23B,K+W3B,K
A TMT4N,K=PR54N,K+PR14B,K+PR24N,K+W4N,K TMT, MT, 4
A TMT5B,K=PR15N,K+PR25N,K+W5N,K TMT, MT, 4
R R4AG,KL=((PR54B,K) (R5,K) + (PR14B,K) (R1,K) + (PR24B,K) (R2,K) + (W4B,K) (B
K K1) / TMT4N,K
R R5AG,KL=((PR15B,K) (R1,K) + (PR25B,K) (R2,K) + (W5N,K) (R5N,K) / TMT5B,K
R R3AG,KL=((PR13B,K) (R1,K) + (PR23B,K) (R2,K) + (W3N,K) (R3N,K) / TMT3B,K 0000164
N R3AG=IR3N
N R4AG=IR4N
N R5AG=IR5N
NOTE THREE-WAY MUTUAL PERCEPTIONS
NOTE
A PLR45,K=R4AG,JK-(PR1,K) (R5AG,JK)
A DLB54,K=R5AG,JK-(PR2,K) (R4AG,JK)
A PLR35,K=R3AG,JK-(PR3,K) (R5AG,JK)
A PLR53,K=R5AG,JK-(PR4,K) (R3AG,JK)
A PLB34,K=R3AG,JK-(PR5,K) (R4AG,JK)
A DLB45,K=R4AG,JK-(PR6,K) (R3AG,JK)
A DLB3,K=(PLR35,K+DLR34,K)/2
A PLR4,K=(DLR45,K+DLR43,K)/2
A DLB5,K=(PLR53,K+DLB54,K)/2
A K3B,K=TABLE (DLR3T,DLR3,K,-100,100,20)
A W3N,K=C3N+W3B,K
A Y4B,K=TABLE (DLR4T,DLR4,K,-100,100,20)
A W4N,K=C4N+W4B,K
A Y5N,K=TABLE (DLR5T,DLR5,K,-100,100,20)
A W5B,K=C5N+W5N,K
NOTE
NOTE ADJUSTMENT PROCESS
L RMB3N,K=RMB3N,J+(NT) (RMB3N,JK)
L RMB4N,K=RMB4N,J+(OT) (RMB4N,JK)
L RMB5N,K=RMB5N,J+(OT) (RMB5N,JK)
N RMB3N=IR3N
N RMB4N=IR4N
N RMB5N=IR5N
A R3N,K=RMB3 (RC7N5T,RMB3N,K)

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A      B4N,K=MAX(BCONST,PB4N,K)
A      B4N,K=MAX(BCONST,PB5N,K)
A      B3TRG,K=YABHL(TB3TRG,B3AG,JK,0,200,20)
A      NB3TRG,K=(B3TRG,K)(P3AG,JK)
A      PB3N,KL=CL(P1R43N1,K,PB3N2,K,PLA35,K,NB3TRG,K)
A      PB3N1,K=(P3AG,JK-PB3N,K)/DT
A      PB3N2,K=(PB3N,K)(-PLA35,K/TRR35,K)+(PB3N4,K)(-PLA34,K/TRR34,K)
A      PB4N,KL=CL(P1R44N1,K,PB4N2,K,PLA35,K,NB3TRG,K)
A      PB4N1,K=(P3AG,JK-PB4N,K)/DT
A      PB4N2,K=(PB4N,K)(-PLA43,K/TRR43,K)+(PB4N4,K)(-PLA45,K/TRR45,K)
A      PB5N,KL=CL(P1R45N1,K,PB5N2,K,PLA35,K,NB3TRG,K)
A      PB5N2,K=(PB5N,K)(-PLA53,K/TRR53,K)+(PB5N4,K)(-PLA54,K/TRR54,K)
A      PB5N1,K=(P3AG,JK-PB5N,K)/DT
A      BVAN,K=(M3)(P3AG,JK)+(M4)(P4AG,JK)+(M5)(P5AG,JK)
A      P45,K=P45,K-PB4N,K
A      PB14,K=P1,K-P44N,K
A      PB13,K=P1,K-P43N,K
A      PB15,K=P1,K-P45N,K
A      PB23,K=P2,K-P44N,K
A      PB24,K=P2,K-P44N,K
A      PB25,K=P2,K-P45N,K
A      P5B,K=YABHL(P5BT,ORS,K,-200,200,40)
A      P13B,K=YABHL(P13BT,CB13,K,-200,200,40)
A      P14B,K=YABHL(P14BT,PB14,K,-200,200,40)
A      P15B,K=YABHL(P15BT,DR15,K,-200,200,40)
A      P23B,K=YABHL(P23BT,PB23,K,-200,200,40)
A      P24B,K=YABHL(P24BT,PB24,K,-200,200,40)
A      P25B,K=YABHL(P25BT,PB25,K,-200,200,40)
A      PR54B,K=YABHL(PR54BT,P5B,K,0,100,10)
A      PR13B,K=YABHL(PR13BT,P13P,K,0,100,10)
A      PR14B,K=YABHL(PR14BT,P14P,K,0,100,10)
A      PR15B,K=YABHL(PR15BT,P15P,K,0,100,10)
A      PR23B,K=YABHL(PR23BT,P23P,K,0,100,10)
A      PR24B,K=YABHL(PR24BT,P24P,K,0,100,10)
A      PR25B,K=YABHL(PR25BT,P25P,K,0,100,10)
A      WRB35,K=YABHL(WRB35T,CTIME,K,0,300,30)
A      TRR35,K=YABHL(TRR35T,CTIME,K,0,300,30)
A      WRB34,K=YABHL(WRB34T,CTIME,K,0,300,30)
A      TRR34,K=YABHL(TRR34T,CTIME,K,0,300,30)
A      WRB43,K=YABHL(WRB43T,CTIME,K,0,300,30)
A      TRR43,K=YABHL(TRR43T,CTIME,K,0,300,30)
A      WRB45,K=YABHL(WRB45T,CTIME,K,0,300,30)
A      TRR45,K=YABHL(TRR45T,CTIME,K,0,300,30)
A      WRB53,K=YABHL(WRB53T,CTIME,K,0,300,30)
A      TRR53,K=YABHL(TRR53T,CTIME,K,0,300,30)
A      WRB54,K=YABHL(WRB54T,CTIME,K,0,300,30)
A      TRR54,K=YABHL(TRR54T,CTIME,K,0,300,30)
A      MPL1=(M11)(B1,K)+(M12)(BVAN,K)
A      MPL2,K=(M22)(B2,K)+(M23)(BVAN,K)
A      PLTAR,K=BVAN,K-BVAN,K
A      PLTA1,K=MPL1,K-BVAN,K
A      PLTA2,K=MPL2,K-B2,K
A      C5,K=YABHL(TTA5,DLTAR,K,0,500,500)
A      C1,K=YABHL(TTA1,DLTA1,K,0,500,500)
A      C2,K=YABHL(TTA2,DLTA2,K,0,500,500)

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NOYF

[illegible]

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9 RC4N.KL=CLIP(RC4N1.K,PC4N2.K,CLC35.K,W3TRG.K)
9 RC4N1.K=(C3AG.JK-MC4N.K)/DT
9 RC4N2.K=(WRC43.K)/(-DL C43.K/TRC43.K)+(WRC45.K)/(-DL C45.K/TRC45.K)
9 RC5N.KL=CLIP(RC5N1.K,RC5N2.K,CLC35.K,W3TRG.K)
9 RC5N1.K=(WRC53.K)/(-DL C53.K/TRC53.K)+(WRC54.K)/(-DL C54.K/TRC54.K)
9 RC5N2.K=(C3AG.JK-MC5N.K)/DT
9 XCVAN.K=(W3)(C3AG.JK)+(W4)(C4AG.JK)+(W5)(C5AG.JK)
9 CVAN.K=MAX(MCVAN.K,CTMIN)
9 DCS.K=C5.K-C4N.K
9 DC14.K=C1.K-C4N.K
9 DC13.K=C1.K-C3N.K
9 DC14.K=C1.K-C5N.K
9 DC23.K=C2.K-C3N.K
9 DC24.K=C2.K-C4N.K
9 DC25.K=C2.K-C5N.K
9 PSC.K=TABHL(PSCY,DCS.K,-200,200,40)
9 P13C.K=TABHL(P13CT,DC13.K,-200,200,40)
9 P14C.K=TABHL(P14CT,DC14.K,-200,200,40)
9 P15C.K=TABHL(P15CT,DC15.K,-200,200,40)
9 P23C.K=TABHL(P23CT,DC23.K,-200,200,40)
9 P24C.K=TABHL(P24CT,DC24.K,-200,200,40)
9 P25C.K=TABHL(P25CT,DC25.K,-200,200,40)
9 PR54C.K=TABHL(PR54CT,PSC.K,0,100,10)
9 PR13C.K=TABHL(PR13CT,P13C.K,0,100,10)
9 PR14C.K=TABHL(PR14CT,P14C.K,0,100,10)
9 PR15C.K=TABHL(PR15CT,P15C.K,0,100,10)
9 PR23C.K=TABHL(PR23CT,P23C.K,0,100,10)
9 PR24C.K=TABHL(PR24CT,P24C.K,0,100,10)
9 PR25C.K=TABHL(PR25CT,P25C.K,0,100,10)
9 WRC35.K=TABHL(WRC35T,CTIME.K,0,300,30)
9 TRC35.K=TABHL(TRC35T,CTIME.K,0,300,30)
9 WRC34.K=TABHL(WRC34T,CTIME.K,0,300,30)
9 TRC34.K=TABHL(TRC34T,CTIME.K,0,300,30)
9 WRC43.K=TABHL(WRC43T,CTIME.K,0,300,30)
9 TRC43.K=TABHL(TRC43T,CTIME.K,0,300,30)
9 WRC45.K=TABHL(WRC45T,CTIME.K,0,300,30)
9 TRC45.K=TABHL(TRC45T,CTIME.K,0,300,30)
9 WRC53.K=TABHL(WRC53T,CTIME.K,0,300,30)
9 TRC53.K=TABHL(TRC53T,CTIME.K,0,300,30)
9 WRC54.K=TABHL(WRC54T,CTIME.K,0,300,30)
9 TRC54.K=TABHL(TRC54T,CTIME.K,0,300,30)
NOTE DESIRED RATE OF ADJUSTMENT
NOTE = PROBLEM MAGNITUDE / TIME TO ADJUST
9 ADRA2.K=DLTA2.K/CVAN.K
9 ADRA1.K=DLTA1.K/C1.K
9 ADRA2.K=DLTA2.K/C2.K
NOTE
9 ADRA2.K=CLIP(0,ADRA2.K,0,DLTA2.K)
9 ADRA1.K=CLIP(0,ADRA1.K,0,DLTA1.K)
9 ADRA2.K=CLIP(0,ADRA2.K,0,DLTA2.K)
NOTE DIFFERENCES IN DESIRED RATES OF ADJUSTMENT BETWEEN OBJECTIVE
NOTE GROUPS AND NWARD - DRIVING FORCE FOR RESPONSE
9 DIFP1.K=ADRA2.K-ADRA1.K 00 1
9 DIFP2.K=ADRA2.K-ADRA2.K 002
NOTE
NOTE ABOVE DIFFERENCES ARE COMPARED WITH TOLERANCE TO DIFFERENCE IN RATE.

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NOTE YIELDING AN 'ACTION' OR 'RESPONSE' INDEX
NOTE
A   ADR1.K=(DRT1.K)(CRA1.K)(CDR1)
C   CDR1=1
A   ADR2.K=(DRT2.K)(DRA2.K)
NOTE
NOTE
NOTE TOLERANCE LIMITS ON RATES OF ADJUSTMENT
NOTE EACH OBJECTIVE GROUP RESPONDS WITH SOME LEVEL OF ACTION WITHIN THE
NOTE TOLERANCE LIMIT. OUTSIDE THE LIMIT, THE RESPONSE IS ZERO.
NOTE THE TOLERANCE LIMIT IS A FUNCTION OF THE PROBLEM MAGNITUDE.
NOTE
A   DRT1.K=TABHL(DRT1TB,DLTA1.K,0,2E06,2E05)
A   DRT2.K=TABHL(DRT2TB,DLTA2.K,0,2E06,2E05)
A   SAT2.K=TABHL(SAT2TB,DLTA2.K,0,2E06,2E05)
NOTE
NOTE
NOTE CONSTANTS AND TABLES FOR DESIRED RATE FUNCTIONAL AREA
NOTE
NOTE END DESIRED RATE FUNCTIONAL AREA
NOTE FUNCTIONAL AREA FOR RESPONSE
NOTE
A   AST.K=(SAT2.K)(DRA2.K)
A   DRR1.K=MAX(CDR1,ADR1.K)
A   DRR2.K=MAX(CDR2,ADR2.K)
A   ST.K=MAX(STC,AST.K)
A   AI1.K=CLIP(0,AK1.K,DIFR1.K,DRR1.K)
A   AX1.K=CLIP(ADR.K,100,DIFR1.K,DRR1.K)
A   ADR.K=(100)(DRR1.K-DIFR1.K)/(DRR1.K)
C   CDR1=1/CDR2=1/STC=2
NOTE
A   AI2.K=CLIP(100,AX2.K,DIFR2.K,ST.K)
A   AX2.K=CLIP(AUX12.K,0,DIFR2.K,DRR2.K)
A   AUX12.K=(100)(DIFR1.K-DRR2.K)/(ST.K-DRR2.K)
NOTE
NOTE IMPACT ON STAFF OF PRAS
A   IAS.K=(ISTF)(IPRAS.K)
NOTE
NOTE IMPACT ON OG 2 OF CIFR2
A   IIF2.K=(I2)(AI2.K)
NOTE
NOTE ACTION INDEX GENERATES DECISION ON PART OF OG 1 TO GENERATE
NOTE PROPAGANDA. CHANGE LEVEL OF COMMITMENT
NOTE
A   IINF1.K=TABHL(I11T,AI1.K,0,100,10)
NOTE
A   DEC1.K=TABHL(D1T,AI1.K,0,100,10)
NOTE
NOTE CHANGE IN LEVEL OF COMMITMENT - FROM DESIRED RATE, BOARD PRESSURE
NOTE THROUGH ACTION INDEX TO DEC1. DEC1 MAY BE THOUGHT OF AS A
NOTE DEGREE OF TREATMENT IN A SPENT/POLLUTION UNIT REMOVED OR TREATED
NOTE
NOTE LEVEL OF COMMITMENT
NOTE
L   LCON.K=LCON.J+(DT)(CCLCON.JK-CLCON.JK)

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9 CCLCON,KL=CLIPICLCON,K,PLCON,K,PTRG,K,DIFRIS,K)
A PTRG,K=(PRAB,K)(APTRG,K)(CPTRG)
C CPTRG=100
A APTRG,K=TABHL(YATRG,PRAB,K,0,200,20)
A CLCON,K=(DEC1,K)(CRA1,K)
A PLCON,K=(DEC2,K)(CRAB,K)
A DIFRIS,K=PRAB,K-CRA1,K
A DEC2,K=TABHL(DEC2TB,PLTAR,K,0,200E06,200E09)
9 LCON=ILCON
9 DLCCM,KL=LCCM,K/DECCM DECAY OF COMMITMENT LEVEL
NOTE
NOTE IMPACT OF COMMITMENT ON TREATMENT
NOTE
A ICON,K=TARHL(ICENT,ALCON,K,0,1F06,1F05)
A ALCON,K=(LCCM,K)(KLCON)
C KLCON=30
NOTE
NOTE CHANGE IN LEVEL OF TREATMENT. NPCT IS MAX. POSSIBLE CHANGE IN TREATMENT
NOTE =F(LT). MRT=MAX. RATE OF INTRODUCTION, PCT./MONTH. NOTE THAT LT IS
NOTE EXPRESSED AS A PERCENT REMOVAL OF POLLUTION ENTERING THE ENVIRONMENT
NOTE FROM THE GENERATING LEVELS
NOTE
9 CT,KL=(ICON,K)(MRT)(IMPCT,K)(100)
A NPCT,K=TARHL(NPCTT,LT,K,0,100,5)
NOTE
NOTE LEVEL OF TREATMENT
NOTE
L LT,K=LY,J+(DT)(CT,JK-LOST,JK) LOSS OF TREATMENT CAPACITY
9 LOST,KL=LT,K/MS
9 LY=ILT
NOTE
NOTE CHANGE IN ACTUAL POLLUTION LEVEL DUE TO TREATMENT, WASTE ASSIMILATION
NOTE CAPACITY OF ENVIRONMENT - TREATMENT ACTS ON ENTERING WASTE STREAMS,
NOTE ASSIMILATION ON ACCUMULATED POLLUTION IN ENVIRONMENTAL RESERVOIR
NOTE
9 RDAPL,KL=(.01)(LY,K)(RGAPL,JK)+(WAM)(APL,K)
NOTE
NOTE PERCEIVED RATE OF ADJUSTMENT OF STAFF BASED ON INFORMATION
NOTE RECEIVED, CONCEPT OF OG 1. PRAS IS RISTABLE - EITHER-OR, RATE
NOTE OF COMPLIANCE IS TOLFPABLE OR RATE OF COMPLIANCE IS ZERO. BEHAVIORAL
NOTE FUNCTION OF STAFF FOR SPECIFIC OBJECTIVE GROUP GOVERNS.
9 IPRAS,K=TABHL(OUTB,IINF1,K,0,1,1)
NOTE
A OA3,K=A3N,K-A9AG,JK
A OA4,K=A4N,K-A4AG,JK
A OA5,K=A5N,K-A9AG,JK
A OA3,K=B3N,K-B9AG,JK
A OB4,K=B4N,K-B4AG,JK
A OB5,K=B5N,K-B9AG,JK
A OC3,K=C3N,K-C9AG,JK
A OC4,K=C4N,K-C4AG,JK
A OC5,K=C5N,K-C9AG,JK
NOTE TABLES AND CONSTANTS FOR RESPONSE AREA
NOTE
NOTE END FUNCTIONAL AREA FOR RESPONSE

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A-11

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C      MAXC1=.05
C      MAXC2=.7
NOTE *****START DATA PERCEIVED LEVEL*****
NOTE
C      AMP3=1
C      AMP1=.4
C      AMP2=1.6
C      W11=.7
C      W22=.9
C      W19=.3
C      W28=.1
NOTE
NOTE
T      SAY2TB=1/.9/.9/.7/.6/.5/.4/.3/.2/.1/.1
T      DRY1TB=.1/.1/.2/.4/.6/.1/.2/.3/.4/.5/.6
T      DRY2TB=.5/.4/.3/.2/.1/.0/.0/.0/.0/.0
NOTE *****END DATA TIME TO ADJUST AREA*****
NOTE *****DATA FUNCTIONAL AREA FOR RESPONSE*****
C      ILCOM=0
C      DECOM=6
C      MMT=.2
C      DMS=60
C      ILT=0
T      OUTB=0/0/0/0/1/1/1/1/1/1/1
C      WAM=.1
C      I2=.01
C      ISTF=.01
T      ITT=0/0/.2/.4/.6/.8/1/1.2/1.4/1.6/1.8
T      OTT=0/0/0/0/0/0/.1/.3/.7/1/2
T      ICOMT=0/0/0/.1/.2/.4/.6/.8/1/1/1
NOTE
T      MPCTT=1/.95/.9/.85/.8/.75/.7/.6/.5/.4/.3/.25/.2/.15/.1/.1/.05/0
X      /0/0
NOTE
NOTE
NOTE
NOTE
T      DLA3T=70/76/82/88/94/100/100/100/95/70/70
T      DLR3T=70/76/82/88/94/100/100/100/65/70/70
T      DLC3T=70/76/82/88/94/100/100/100/55/70/70
T      DLA4T=34/34/34/51/70/70/70/51/34/34/34
T      DLR4T=34/34/34/51/70/70/70/51/34/34/34
T      DLC4T=34/34/34/51/70/70/70/51/34/34/34
T      DLA5T=20/36/52/68/84/100/84/68/52/36/20
T      DLR5T=20/36/52/68/84/100/84/68/52/36/20
T      DLC5T=20/36/52/68/84/100/84/68/52/36/20
T      TA3TRG=.4/.38/.36/.34/.32/.3/.28/.26/.24/.22/.2
T      TB3TRG=.4/.38/.36/.34/.32/.3/.28/.26/.24/.22/.2
T      TC3TRG=.4/.38/.36/.34/.32/.3/.28/.26/.24/.22/.2
C      W3=.33/W4=.33/W5=.33
NOTE
NOTE
T      PSAT=100/76/54/32/10/10/10/10/12/54/76/100
T      PSRT=100/76/54/32/10/10/10/10/12/54/76/100
T      PSTY=100/76/54/32/10/10/10/10/12/54/76/100
T      P13AT=100/75/45/15/0/0/0/0/0/0/0
T      P13RT=100/75/45/15/0/0/0/0/0/0/0
T      P13CT=100/75/45/15/0/0/0/0/0/0/0

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MAX CHANGE IN DL1
MAX CHANGE IN DL2
POLLUTION AMP. FACTOR
POLLUTION AMP. FACTOR
POLLUTION AMP. FACTOR
WT. FOR WTD. PERC. POLLUTION
WT. FOR WTD. PERC. POLLUTION
WT. FOR WTD. PERC. POLLUTION
WT. FOR WTD. PERC. POLLUTION
IMPACT OF PROB. MAGNITUDE
ON CHANGE IN TIME TO ADJUST

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INITIAL LEVEL OF COMMITMENT
MAX. RATE INTRO. NEW TREATMENT
ORSOLESCENCE FACTOR MONTHS
INITIAL LEVEL OF TREATMENT
STAFF PERC. COMPLIANCE FUNCTION
WASTE ASSIMILATION FACTOR
INFLUENCE FACTOR FOR A12
INFLUENCE FACTOR A15
IMPACT A11 ON 1 INFORMATION
DECISION TABLE 8 SPENT/PU FLIP
IMPACT OF COMMITMENT ON TREAT.
EFFICIENCY OF INC. TREATMENT

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00000362
00000364
00000370
00000372

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00000376
0070

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00000382
00000382
000003
00000384
00000386
00000388

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00000390

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T	P14AT=7/7/0/7/30/7/7/0/0/0/0	
T	P14AT=0/7/7/0/7/30/7/7/0/0/0/0	00700392
T	P14CT=0/7/7/0/7/30/7/7/0/0/0/0	
T	P15AT=0/7/7/0/7/30/7/7/0/0/0/0	
T	P15AT=0/7/7/0/7/30/7/7/0/0/0/0	00707394
T	P15CT=0/7/7/0/7/30/7/7/0/0/0/0	
T	P23AT=17/10/10/10/10/10/70/100/100/100	
T	P23BT=10/10/10/10/10/10/70/100/100/100	00707396
T	P23CT=10/10/10/10/10/10/70/100/100/100	
T	P24AT=0/0/0/0/0/0/0/0/0/0/0	
T	P24AT=0/0/0/0/0/0/0/0/0/0/0	00707398
T	P24CT=0/0/0/0/0/0/0/0/0/0/0	
T	P25AT=17/10/10/10/10/10/35/0/0/0/0	
T	P25AT=17/10/10/10/10/10/35/0/0/0/0	00707400
T	P25CT=10/10/10/10/10/10/35/0/0/0/0	
NOTE		
T	PR54AT=0/7/13/27/27/33/40/47/53/60/60	00000402
T	PR54BT=0/7/13/27/27/33/40/47/53/60/60	00000404
T	PR54CT=0/7/13/27/27/33/40/47/53/60/60	
T	PR13AT=20/24/28/32/36/40/45/50/50/50/50	
T	PR13AT=20/24/28/32/36/40/45/50/50/50/50	00000406
T	PR13CT=20/24/28/32/36/40/45/50/50/50/50	
T	PR14AT=30/34/38/42/46/50/54/58/62/66/70	
T	PR14AT=30/34/38/42/46/50/54/58/62/66/70	00000408
T	PR14CT=30/34/38/42/46/50/54/58/62/66/70	
T	PR15AT=30/35/40/45/50/55/60/65/70/75/80	
T	PR15AT=30/35/40/45/50/55/60/65/70/75/80	00000410
T	PR15CT=30/35/40/45/50/55/60/65/70/75/80	
T	PR23AT=10/14/18/22/26/30/35/40/45/50/55	
T	PR23BT=10/14/18/22/26/30/35/40/45/50/55	00007412
T	PR23CT=10/14/18/22/26/30/35/40/45/50/55	
T	PR24AT=0/3/7/10/13/16/20/15/10/5/0	
T	PR24AT=0/3/7/10/13/16/20/15/10/5/0	00007414
T	PR24CT=0/3/7/10/13/16/20/15/10/5/0	
T	PR25AT=10/11.5/13/14.5/16/17.5/19/20/20/20/20	
T	PR25AT=10/11.5/13/14.5/16/17.5/19/20/20/20/20	00700416
T	PR25CT=10/11.5/13/14.5/16/17.5/19/20/20/20/20	
NOTE		
NOTE		
NOTE	ADJUSTMENT TIMES AND WEIGHTS FOR MUTUAL ADJUSTMENT	
T	WRA35T=.3/.3/.3/.3/.3/.3/.3/.3/.3/.3	00700418
T	WRB35T=.3/.3/.3/.3/.3/.3/.3/.3/.3/.3	00707422
T	WRC35T=.3/.3/.3/.3/.3/.3/.3/.3/.3/.3	00007424
T	TRA35T=10/10/10/10/8.5/6/3.5/2/2/2/2	00700426
T	TRB35T=10/10/10/10/8.5/6/3.5/2/2/2/2	
T	TRC35T=10/10/10/10/8.5/6/3.5/2/2/2/2	00007428
T	WRA34T=.7/.7/.7/.7/.7/.7/.7/.7/.7/.7	
T	WRB34T=.7/.7/.7/.7/.7/.7/.7/.7/.7/.7	00007430
T	WRC34T=.7/.7/.7/.7/.7/.7/.7/.7/.7/.7	
T	TRA34T=10/10/10/10/8.5/6/3.5/2/2/2/2	
T	TRB34T=10/10/10/10/8.5/6/3.5/2/2/2/2	
T	TRC34T=10/10/10/10/8.5/6/3.5/2/2/2/2	
NOTE		
T	WRA43T=.2/.2/.2/.2/.32/.5/.68/.8/.8/.8	00000434
T	WRB43T=.2/.2/.2/.2/.32/.5/.68/.8/.8/.8	00007436
T	WRC43T=.2/.2/.2/.2/.32/.5/.68/.8/.8/.8	

T	TRA43T=4/3.5/3/2.5/2/2/2/2/2/2	0000343R
T	TRH43T=4/3.5/3/2.5/2/2/2/2/2/2	
T	TRC43T=4/3.5/3/2.5/2/2/2/2/2/2	
T	WRA45T=.8/.9/.9/.68/.5/.32/.2/.2/.2/.2	00000440
T	WRH45T=.8/.9/.9/.68/.5/.32/.2/.2/.2/.2	
T	WRC45T=.8/.9/.9/.68/.5/.32/.2/.2/.2/.2	
T	TRA45T=3/3/3/3/3/3/3/3/3/3	00000442
T	TRH45T=3/3/3/3/3/3/3/3/3/3	
T	TRC45T=3/3/3/3/3/3/3/3/3/3	
NOTE		00000444
T	WRA53T=.2/.2/.2/.2/.39/.75/.55/.5/.9/.9	00000446
T	WRH53T=.2/.2/.2/.2/.39/.75/.55/.5/.9/.9	
T	WRC53T=.2/.2/.2/.2/.39/.75/.55/.5/.9/.9	
T	TRA53T=9/9/9/9/7.5/5.5/3.5/2/2/2/2	00000448
T	TRH53T=9/9/9/9/7.5/5.5/3.5/2/2/2/2	
T	TRC53T=9/9/9/9/7.5/5.5/3.5/2/2/2/2	
T	WRA54T=.8/.9/.9/.9/.62/.25/.33/.45/.5/.5/.5	00000450
T	WRH54T=.8/.9/.9/.9/.62/.25/.33/.45/.5/.5/.5	
T	WRC54T=.8/.9/.9/.9/.62/.25/.33/.45/.5/.5/.5	
T	TRA54T=2/2/2/2/2/2/2/2/2/2	00000452
T	TRH54T=2/2/2/2/2/2/2/2/2/2	
T	TRC54T=2/2/2/2/2/2/2/2/2/2	
C	C3A=5/C4A=5/C5A=5	
C	C3B=5/C4B=5/C5B=5/C3C=5/C4C=5/C5C=5	
C	ACONST=7/ACONST=0/CCONST=7	
C	CSCAL=.75	
PLNT	APL=010.20000000/LCON=CIC.60FC31/LT=TIC.1000	
PLNT	PHIL,DBIL,OTFRU/ALAM	
PLNT	APL/LG/LCON/LT/ALL/OTFR1/DRR1/ORT1	
PLNT	RG/RDBUL/RGAPL,RDAPL	
PLNT	DRAB,ORA1,ORA2/DLTAB,DLTA1,DLTA2	
PLNT	A3AG,A4AG=F,A5AG=9,AS=5,A1=1,A2=2	
PLNT	B3AG,B4AG=F,B5AG=9,BS=5,B1=1,B2=2	
PLNT	C3AG,C4AG=F,C5AG=9,CS=5,C1=1,C2=2	
PLNT	DLA39,NA3TRG/DLB39,NA3TRG/PLC39,NC3TRG	
PLNT	CCLCOM,DLCOM,CLCOM,PLCOM/PTRG,OTFR15	
PLNT	GA3,GA4,QA3/QB3,QA4,QA5/QC3,QA4,QA5	
RUN	TEST BASE	
C	CDRR1=15	
RUN	TEST1	
C	CDRR1=30	
RUN	TEST2	
C	CDRR1=1/CDTRG=.5	
RUN	TEST3	
C	CDRR1=30	
C	CDTRG=.5	
RUN	TEST4	
C	CKRD2=.45E-10/CKRG2=.2E-06	
RUN	TEST5	
C	CRG1=0	
RUN	TEST6	
C	CRG1=.7.9F06/CRG2=.3F06	
RUN	TEST7	
C	CRG2=.3E04/CKRD2=.45E-10/CKRG2=.2E-06	
RUN	TEST8	
C	CRG1=120	
RUN	TEST9	
/0		

APPENDIX B

ROLE AWARENESS PROGRAM PACKAGE

B-I Instructions to Role Players

B-II Case Problem

APPENDIX B-1

ROLE PLAYER

You are about to participate in a role playing exercise involving a Regional Board review of a waste discharge case. On the following page, you will find a description of one of the participants in this situation. In this exercise you will be playing this role. Read the description of the individual, to understand some of the background and concerns of the participant. The role playing should represent your own personality as supplemented or changed by the instructions, situation, and feelings engendered by the interaction.

OBSERVER

You are about to observe a role playing exercise involving a Regional Board review of a waste discharge case. On the following page you will find the instructions for one of the participants in this exercise. Please read the instructions and pay particular attention to the actions of this person. You should be especially attentive to:

- (1) How this person handles a situation.
- (2) Other participants' reactions to him.
- (3) His reactions to other participants.
- (4) Factors which interfered with communication.
- (5) Weight he gave to various factors in the decision.
- (6) Did the participant make a statement in conflict with another speaker?
- (7) What was the reaction of others?
- (8) Did someone else make a statement in conflict with your observed role? How was it handled?
- (9) How could this response have been improved?

We will discuss the group's answers after the role-playing is completed.

Mr. White

EXECUTIVE OFFICER

You are Executive Officer for Region 15 of the Water Quality Control Board. One of the cases the Board is going to hear today involves the Zoom Oil and Refining Company. For nine of the last twelve months the company has been violating discharge requirements set by the Board. These violations are substantiated by the company's self-monitoring reports and your staff's observation and analysis. Your efforts to resolve this situation have failed. Eight months ago (after your first contact with them) they set up a task force to study the problem and develop improvements in the treatment operation, but no facilities are under construction.

Zoom is a medium sized corporation owned by a large corporation. If Zoom doesn't have the necessary money for treatment facilities they should get it from their parent company.

There is a yacht club 1/2 mile downstream from Zoom which claims it is losing business because of floating grease and odor caused by the Zoom discharge. In addition, there was a large fish kill 3 days ago about 1/2 miles from Zoom. Your staff has been monitoring the water regularly for the last eight months. The last inspection was yesterday.

You think Zoom's timing in dealing with this problem is unreasonable and are recommending that the board issue a cease-and-desist order giving Zoom four months to build new facilities. You are also recommending they issue a clean-up order.

You notified the discharger of this hearing 15 days ago and sent them a copy of the staff report.

Your board has a good record in protecting the environment and you are proud of this reputation.

People scheduled to testify today include:

- (1) Mr. Craig representing Zoom Oil Co.
- (2) Mr. Watson of the Cove Bay Yacht Club.
- (3) Mr. Sherwood from Fish and Game.
- (4) Mr. Gold of your staff.

In addition, Mr. Brown, from the State Board is in the audience.

Mr. Craig

DISCHARGER

You have been appointed by your company (Zoom Oil and Refining Co.) to appear before the Regional Water Quality Control Board to answer charges that your company has been violating discharge requirements set by the board. Your company is medium sized, totally owned by Elton Inc., and has been in operation for two years. For nine of the last twelve months your company has violated the discharge requirements, based on a self-monitoring record.

Two main problems you have to answer are:

- (1) A fish kill which occurred last week about 1/2 mile downstream from your point of discharge (no fish were killed near your area however).
- (2) A small yacht club 1/2 mile downstream claims he is losing business because of the odor and water pollution caused by your company.

The board's staff is asking for a cease-and-desist order, and a clean-up order. Eight months ago your company set up a task force to analyze the problem and make recommendations. They have made tentative recommendations and are now trying to find the best solution at the lowest price.

Since your company is not large and you haven't been in business long, you need the money required for waste treatment facilities for more important purposes. In fact, you might be forced out of business unless your parent company can give you money for the facilities.

You are to argue for more time for the task force to make recommendations for the least expensive method of meeting the requirements and for you to get the money to implement it. You have 200 employees working for you and if you are put out of business they would have difficulty finding other jobs considering the present economic conditions. The community needs you. Any temporary arrangements would be costly and not be a part of the final solution, so this would add even more costs. It would take approximately seven months to build the necessary treatment facilities.

Your company is concerned about this problem and plans to take care of it, but you need time.

Mr. Jones

BOARD CHAIRMAN

The case you are about to hear involves an oil company which has violated discharge requirements for nine of the last twelve months. The company is relatively new (2 years) and not large. They are not in financial trouble, but don't really have the money to spend on the facilities to meet the requirements. They are conscious of the problem and are really trying to do something about it. They set up a task force to study the problem eight months ago, but no construction has begun.

You can understand their problem since you are manager of a papermill about their size and remember going through some of the same financial problems when you first started. You also have a responsibility as a board member to protect the environment in a reasonable and expeditious manner.

You are the industrial representative on the Board.

Mr. Brown, from the State Board is in the audience observing this hearing. He can be asked questions concerning the State's view of this case.

Mr. Bond

BOARD MEMBER

You are about to hear a case involving an oil company discharging wastes into a bay. For nine of the last twelve months the company has violated the discharge requirements. There seems to be little question as to whether they have violated the requirements, the question is whether they have had a reasonable time to correct the situation, the economic effect on the company, and the damage caused by their pollution.

Your community is mainly dependent on agriculture. This company is the single largest employer in the county, and promises to grow even larger and help the community prosper. Economic conditions are bad now and if this company were closed the effects would be disastrous.

The P-C/act has been in effect for one year and there is pressure on you from conservation groups, etc., to apply the law vigorously.

You are the agricultural representative of the Board.

Mr. Brown, a member of the State Board is attending this hearing.

Mr. Green

BOARD MEMBER

The case you are about to hear involves an oil co. which has been violating discharge requirements for nine of the last twelve months. Three days ago, there was a fish kill about 1/2 mile downstream from their discharge point. This company isn't too large but they are owned by a very large company. So if this company couldn't afford to treat their waste, their parent company certainly can. Your responsibility is to clean up the environment in a reasonable and expeditious manner.

The company realizes the problem and is trying to do something about it. They just need more time. They employ 200 people and are a real asset to the community.

You are a representative of municipal government on the Board, and understand how sometimes it is difficult to raise money for updating waste treatment facilities because of the problems involved in raising funds from bonds, etc.

Mr. Dorn

BOARD MEMBER

The case you are about to hear involves an oil co. which has violated discharge requirements for nine of the last twelve months. They have a task force working on the problem, but nothing has been started. Meanwhile, a yacht club 1/2 mile downstream from the company's discharge point is on the verge of going out of business because of the pollution and odor.

Your duty, as a public servant, is to clean up the environment in a reasonable and expeditious manner.

You represent water supply, conservation and production on the Board.

Mr. Clayton

BOARD MEMBER

The case you are about to hear involves an oil company which has violated discharge requirements for nine of the last twelve months.

The company, in all probability, will grow and help the community prosper.

You are responsible to clean up the environment in a reasonably expeditious manner.

You are the representative of county government on the Board.

The company employs 200 people and is a real asset to the community. Your county is economically depressed now and couldn't afford to have more people unemployed. Jobs just aren't available. The company may be forced to close if the boards make them act quickly and spend too much money.

Mr. Morse

BOARD MEMBER

The case you are about to hear involves an oil company which has violated discharge requirements for nine of the last twelve months. While the company isn't large, they are owned by a very large company. So they could always get money to build facilities to treat their discharge. There was a fish kill 1/2 mile downstream from their discharge point a week ago. Fish and Game believes the oil company is responsible. There is a yacht club 1/2 mile downstream from the company discharge point, which has been in operation about 10 years and which is threatened with bankruptcy because of the water pollution. You have a responsibility to clean up the environment in a reasonable and expeditious manner.

You are a professor of Environmental Sciences and realize the potential damage which can be caused by unchecked pollution of the ocean. Everyone thinks because it is large it can take an unlimited amount of waste. However, you are responsible as a board member to recognize the need for economic growth.

Mr. Drake

BOARD MEMBER

The case you are about to hear involves an oil company which has violated discharge requirements for nine of the last twelve months. While the company isn't large, they are owned by a very large company, so they could always get money to build facilities to treat their discharge. There was a fish kill 1/2 mile downstream from their discharge point a week ago. Fish and Game believes the oil company is responsible. There is a yacht club, 1/2 mile downstream from the company discharge point, which has been in operation about 10 years and which is threatened with bankruptcy because of the water pollution. You have a responsibility to clean up the environment in a reasonable and expeditious manner.

You are a Professor of Aquatic Biology and realize the potential damage which can be caused by unchecked pollution of the ocean. Everyone thinks because it is large it can take an unlimited amount of waste, however, you must also recognize the need for economic growth.

Mr. Adams

BOARD MEMBER

The case you are about to hear involves an oil company which has violated discharge requirements for nine of the last twelve months. While the company isn't large, they are owned by a very large company, so they could always get money to build facilities to treat their discharge. There was a fish kill 1/2 mile downstream from the company discharge point, which has been in operation about 10 years and which is threatened with bankruptcy because of the water pollution. You have a responsibility to clean up the environment in a reasonable and expeditious manner.

You are a member of the county planning commission and realize the importance of both the water quality and economic factors in this case.

Mr. Whitaker

BOARD MEMBER

You are about to hear a case involving an oil company which has violated discharge requirements for nine of the last twelve months. Three days ago there was a fish kill 1/2 mile from the companies discharge point. There is also a yacht club which claims that it is losing business because of the grease and odor caused by the plant discharge. Before this company moved in two years ago your waters were clean, attracting fishermen from all over the state. If this company is permitted to pollute unchecked there won't be any fish to catch.

You have a responsibility as a board member to protect the environment. As a board member you also have a responsibility for considering the effects your actions have on the economic well-being of the community.

You are a representative of recreation, fish and wildlife on the Board.

Mr. Brown

BOARD MEMBER

You are a sanitary engineer on the State Water Resources Control Board. You have been sent by your Chairman to observe and report back on the operation of the Regional Board.

While the State Board has not taken an official position on this case, it is interested in seeing the waters of the State cleaned up as soon as possible. The State is also interested in seeing the Porter-Cologne Act implemented as soon as possible to show dischargers the Board intends to enforce the act.

Mr. Gold

STAFF

You are on the staff of Region 15 of the Water Quality Control Board. One of the cases the board is going to hear today involves Zoom Oil and Refining Co. The Executive Officer is going to recommend that the Board issue a cease-and-desist order at today's meeting. You have been inspecting the discharge of this company for a year. For the first eight months you were inspecting once a month. For three months you were inspecting once a week, and for the last two weeks you have been inspecting daily. Your last inspection was yesterday. Analysis of your samples indicates violations. You also inspected the yacht club 1/2 mile from the discharge point and have noticed the floating grease and odor.

Mr. Watson

COVE BAY YACHT CLUB

You represent a yacht club which is about 1/2 mile downstream from the Zoom Oil Company's discharge point in Cove Bay. You have been in operation for ten years and business has been good. However, since Zoom went into operation the water has become more polluted and smells and business is dropping off daily. The water has been getting progressively worse in the last few months. Unless this thing is cleaned up immediately you will be out of business in one year.

Whoever pollutes the water should be forced to clean it up no matter what the cost. You need help quick!

Mr. Sherwood

FISH AND GAME

You are representing the Fish and Game dept. of the State of California. Three days ago there was a large fish kill about 1/2 mile downstream from the Zoom Oil Company. You suspect that the kill was a result of their discharge, but at this point you cannot prove it. No fish were killed in their immediate vicinity, but then fish kills tend to be on the margins of livable water....in other words there probably weren't many fish living around the plant. One of the reasons that you suspect Zoom is that there aren't any other industries discharging in that area.

You want the Board to take action to stop this discharge immediately.

APPENDIX B-II

State of California
California Regional Water Quality Control Board
Coastal Region

MEETING AGENDA

Date: November
Address: International Airport
Time: 1:00 pm
City of Los Angeles: 4:00 pm

1. Call to order.
2. PUBLIC HEARINGS To consider the issuance of a cease-and-desist order against the Zoom Oil and Refining Company.
 - a. Staff presentation.
 - b. Board questions concerning staff report.
 - c. Presentation by discharger and other interested parties.
 - d. Questioning by board members and Executive Officer.
 - e. Final comments and recommendations by Executive Officer.
 - f. Motion by members seconded by another member.
 - g. Board discussion on motion.
 - h. Vote.

State of California
California Regional Water Quality Control Board
Coastal Region

EXECUTIVE OFFICER SUMMARY REPORT

Date: November 20, 1970
Address: 1236 W. Trees Street+
City: Crescent, California

Item: Zoom Oil and Refining Company

Subject: Enforcement Action

Discussion: For nine of the last twelve months the company has been violating discharge requirements set by the Board. They have set up a task force to study the problem and develop improvements, but no facilities are under construction. A yacht club is losing business because of water pollution in the area. Temporary measures can be taken to protect receiving water quality pending development of a permanent solution to the problem of requirement violation.

Recommendation: Issue an order to cease-and-desist forthwith with a compliance time schedule by March 20, 1971. Issue a clean-up and abatement order forthwith.

BOARD INFORMATION SHEET

California Regional Water Quality Control Board
Coastal Region

Board Members

City of Residence

Arthur Jones, Chairman	Quincy, Ca.
William D. Bond, Vice Chairman	Adams, Ca.
Thomas H. Green	Quincy, Ca.
Mr. John Dorn	Quincy, Ca.
Edward J. Clayton	Los Gatos, Ca.
John W. Morse	Los Gatos, Ca.
Lester L. Drake	Ft. Ross, Ca.
William J. Adams	Crescent, Ca.
Ronald B. Whitaker	Crescent, Ca.

Staff

Office Location

Raymond M. White, Executive Officer	1236 W. Trees St. Suite No. 1140
Larry A. Gold, Senior Engineer	Crescent, California 98320

Telephone

(480) 369-6208

General Statement

The primary duty of the Regional Board is to protect the quality of the waters within the region for all beneficial uses. This duty is implemented by formulating and adopting water quality plans for specific ground or surface water basins and by prescribing and enforcing requirements on all domestic and industrial waste discharges. Specific responsibilities and procedures of the Regional Water Quality Control Boards and the State Water Resources Control Board are outlined in the Porter-Cologne Water Quality Control Act.

The purpose of the meeting is for the board to obtain testimony and information from concerned and affected parties and make decisions after considering the recommendations made by the executive officer.

The board and the staff welcome information on pertinent problems, but comments at the meeting should be tried and directed to specifics of the case to enable the board to take appropriate action. Whenever possible, lengthy testimony should be presented to the board in writing and only a summary of pertinent points presented verbally.

STAFF REPORT

Zoom Oil and Refining Company

Conclusions

In 1969, Zoom Oil and Refining Company's plant began operation and repeatedly violated the requirements for grease nine of the 12 months of record. The discharger has established a task force to develop improvements in the treatment operation but no facilities are under construction. Temporary measures can be taken to protect receiving water quality pending development of a permanent solution to the problem of requirement violation.

Recommended Enforcement Action

Issue an order to cease-and-desist forthwith with a compliance time schedule by March 20, 1971 and direct the Executive Officer of the Regional Board to refer the case to the Attorney General if violations persist beyond March 20, 1971.

Issue a clean-up and abatement order forthwith, effective until discharger meets requirements, and direct Executive Officer to refer the case to the Attorney General if order is not complied with.

Waste Discharge

The 72,000 bbl/day petroleum refinery discharges approximately 2 mgd of industrial wastes through two outfalls into Cove Bay. Waste stream A, emanating from the oil refining operation, constitutes 1.5 mgd of wastewater. Treatment facilities consist of desalters, ammonia and sulfide strippers, chemical flocculation, biological treatment, oil separator, and neutralization tanks. Table I is a summary of the treatment facilities and loadings as depicted in the report of waste discharge. Waste stream A is discharged through outfall A, 1,500 feet offshore in about 20 feet of water.

Waste stream B consists of ship ballast water. Treatment facilities consist of a settling and skimming tank sized to receive 30,000 barrels of ballast water every two weeks. The waste is intermittently discharged in 0.5 mgd flows during a three-day period once every two weeks. The waste is discharged 1,000 feet offshore in 14 feet of water through outfall B.

Waste discharge requirements were adopted by the Regional Board on January 17, 1968. The beneficial uses of the receiving waters were determined to be limited body contact recreation, fish and wildlife habitat, and navigation and esthetic appeal.

Violations

The grease requirement for effluent A and the receiving water toxicity requirements have been repeatedly violated. The following is a summary of violations:

Self-Monitoring Data March - November 1970

Requirement Violated	1970-Months Violated	Poorest Sample	Violations Observations
Grease 15 mg/l	March-November	235 mg/l	33/39
Toxicity *	May-November	.02 %	16/30
Settleable Matter 0.5 ml/l/hr	March, October	3.5 ml/l/hr	2/92
Dissolved Oxygen in Bay 5 mg/l	November	4.6 mg/l	11/178
Dissolved Sulfides in Bay 0.1 mg/l	September-November	3.4 mg/l	3/178 **

* Compliance with the toxicity requirements is a function of an assumed dilution factor. The Regional Board has not established the appropriate dilution factor to measure compliance. If the minimum dilution factor of 35:1, as originally estimated in the report of waste discharge is used, the summary of violations would be 27 violations per 30 observations. See Figure 1 for the relationship of TL_m required to meet requirements as a function of dilution factor.

** Two-thirds of violations were out of the diffusion area.

Only one requirement, total suspended solids, out of the five requirements for effluent A have not been violated. Of the ten receiving water requirements, there have been recorded violations of three of the requirements. Effluent B requirements have not been violated. The most severe and repeated violations have been of grease and toxicity requirements.

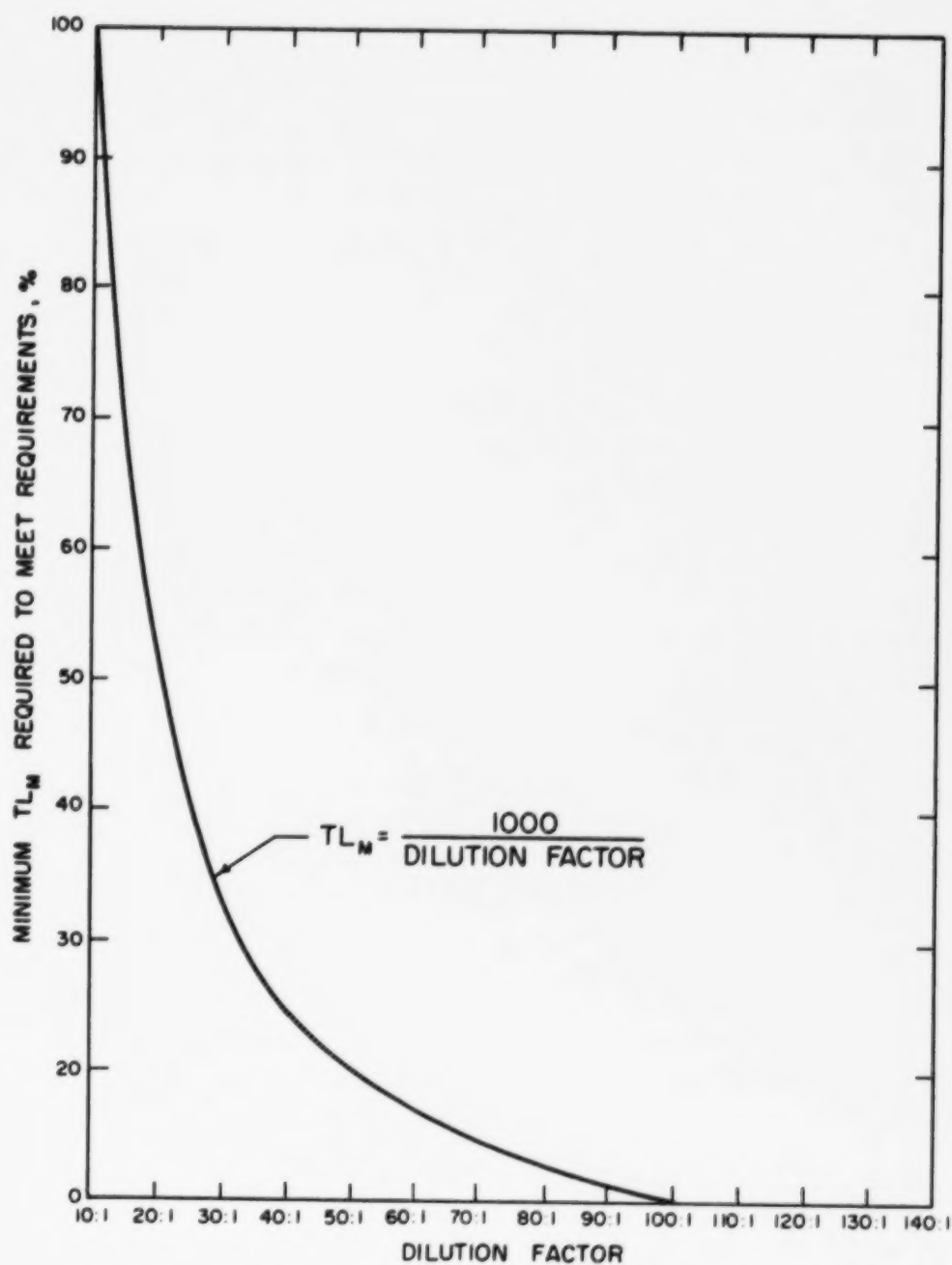
Discharger

The discharger has established a task force to investigate improvements to the treatment operations.

SUMMARY OF SAMPLE REQUIREMENT VIOLATIONS FOR SIX OIL REFINERIES

Refinery	Gulf Oil Co.	Texaco Oil Co.	Mobile Oil Co.	Standard Oil Co.	Union Oil Co.	Zoom Oil Co.	Zoom Oil Co.
Time Required	10/69-9/70	1/70-9/70	4/70-9/70	10/69-9/70	3/70-9/70	1/70-9/70	10/70-12/70
<u>Effluent</u>							
Coliform	19/96	-	5/6	5/14	12/56	-	-
Toxicity	33/58	2/4	0/1	4/4	1/14	-	10/13
pH	-	2/38	9/18	-	-	-	-
Sulfides	0/24	3/76	0/18	-	0/54	-	-
Solids	0/49	0/76	0/74	0/24	32/106	2/104	2/39
Grease	21/49	1/29	22/42	0/12	2/37	21/34	11/12
Phenol	-	11/38	-	-	-	-	-
DO	-	-	0/11	-	-	-	-
BOD	-	-	-	0/12	-	-	-
<u>Receiving Water</u>							
DO	0/15	0/9	0/5	1/12	1/21	0/19	1/2
pH	0/15	0/9	0/7	0/12	4/21	0/19	1/2
Phenols	-	0/9	1/4	-	-	-	-
Odor	0/121	0/9	0/20	0/365	9/14	0/19	-
Sulfides	-	0/9	-	-	-	1/14	1/2
Solids	0/121	0/9	0/20	1/365	8/14	0/19	-
Oil and Grease	0/347	0/9	-	0/365	-	0/19	-
Color and Turbidity	0/347	-	0/20	-	3/14	0/19	-
Ammonia	-	1/9	-	-	-	0/19	-
Heavy Metals	-	-	-	-	-	0/30	-
Excess Algae	-	-	-	-	7/9	-	-

FIGURE - I



MINIMUM TL_M REQUIRED TO MEET REQUIREMENTS
VS ASSUMED DILUTION FACTORS